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Blockchain within Logistics: a SWOT analysis

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Abstract

The industry 4.0 is already developed in many sectors and business. In recent years, some technologies of this trend have appeared in our society providing new business models and improving the effectiveness and efficiency for processes.

One of these technologies is Blockchain, a distributed database of records among participants. It is believed that this technology could revolutionize business and redefine logistics. However, Blockchain is an emerging technology and it is still at an early state of development.

The objetive of this Master Dissertation is to understand what Blockchain is and to measure the impact of this technology in logistics, analyzing the possible limitations and applications and considering professional judgement. Moreover, this work provide a framework to identify the Blockchain opportunities in the logistics industry and helping managers to know where they can implement it in their processes.

The methodology of this work involved three stages: (1) analysis of the literature review to establish the technology basis and the current applications in logistics; (2) The implementation of a SWOT analysis according to recent studies; (3) testing the SWOT analysis using an online interview aimed at experienced business in logistics and cibersecurity. Finally it will be explained the main result of this work.

Keywords: Industry 4.0**,** Blockchain, Logistics, Supply Chain, SWOT analysis

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CHAPTER 1 - INTRODUCTION

Industry 4.0 or the 4th industrial revolution is a seen in the literature as the framework of appearence of several new trends and technologies, such as Blockchain technology. This is the technology under study in this master dissertation.

The main reason to choose this technology is because it is considered to be useful for many companies in their daily operations but most of them do not have a clear knowledge about it and, nowadays, it is not yet fully or partially implemented in their processes.

The introduction is used to contextualize the problem being analysed in this thesis and set the objective of this dissertation. Thereafter, we present an overview of the methodology used and the reasoning behind the structure of the thesis.

1.1 Problem Motivation

In recent years, the logistics sector is experiencing great advances with the introduction of new ways of working and optimizing processes (Pinheiro de Lima et al., 2016) .

Blockchain is a new technology which is transforming current models into distributed platforms characterized by a common consensus among different parties. This technology has shown great potential in some areas where it has been implemented, such as finance, banking and healthcare. However, several studies have been carried out to investigate the applications and uses of this technology, but it is not yet known exactly if it will bring long-term benefits.

In this work we try to study the technology and its possible beneficial used in the logistics field. It is intended to inform about its benefits but also to alert about its risks and threats, providing a broad spectrum and being as objective as possible. Thus, we want to evaluate the potential of implementation within logistics.

Moreover, the scope of the research is not limited to the recent studies analysis. It is aimed to provide a realistic vision about Blockchain and try to study in depth this technology, therefore not only analyzing the knowledge provided by other authors but also doing a SWOT analysis and an interview for putting up our own investigation.

1.2 Objectives

Nowadays, technology is present in many aspects of our life. Especially, the processes and activities have undergone great changes since the manpower was changed by the use of machinery.

With this situation, it is necessary to study the possibilities that we could achieve with the appearance of new technologies.

Moreover, while I was finishing my master, one of the subjects I was very interested was "Technologies and information systems". In this subject I could learn about new ways of doing activities, organizing processes and communication between the several actors in the supply chain or just recording data. Blockchain was one of the most important topic in the subject but we don't know what is going to happen with this technology as it was not totally developed. Therefore I thought that it would be a good idea to make a study about this technology focusing on the logistic sector and the benefits that Blockchain could bring to this area.

Therefore the objetive of this dissertation is to study and analize if this technology would provide real benefits or just the same properties as other similar technologies already implemented in business. With this purpose, it is required to study in deepth the main characteristics of Blockchain, current utilities and uses.

Moreover, it will be done a SWOT analysis trying to obtain a general approach of the main strengths, weakness, opportunities and threats. Getting this information we are able to know the current situation of the technology and how business have to use it to apply in their processes. In addition, we will realize about the lack of information. Therefore, the main goal is to provide researchers in what they have to lead the future investigations.

Finally, an interview will be conducted to verify the information of SWOT analysis by different companies. In addition, another purpose is to be conscious of the knowledge and possition about Blockchain.

In the end, with all the obtained information, the conclusions will be drawn up.

1.3 Overview of Methodology

During this work, a methodology to measure the impact of Blockchain's implementation in technology companies, particularly in the logistics field, will be created. Therefore, in this section the methodology used in the elaboration of this Master dissertation to achieve the final conclusions will be described.

First it is needed to set the definition of logistics in general terms and to make an explanation of

the activities included in it, delving into new business models which have emerged in recent years applications.

Two different databases have been used: Google Scholar and Web of Science. The goal was to find papers from different years and authors to display the progress in the logistics sector and to give a truthful vision. The keywords used were logistics, logistics-business and logistics-management.

Moreover, to analyze the impact of Blockchain in logistics, it was necessary to carry out a literary study on the current trend of the industry towards Industry 4.0, being Blockchain a part of it, as well as understanding and defining essential terms such as logistics and the supply chain. A review fof logistics and Industry 4.0 was made, trying to address the main characteristics of both and making a general investigation of these two concepts.

Therefore, it will be explained what is the Industry 4.0 and the main trends and technology which compose it. In this case, it has been selected a wide number of papers related to the topic, but it has been filtered and analyzed the most relevant depending on the content or the used language being more than 50 papers analyzed. The keywords which have been used for the filtering were: Industry 4.0, Industry 4.0 applications, Industry 4.0 logistics, Industry 4.0 challenges.

Once these concepts were understood and settled, Blockchain analysis was carried out specifically. The objective was to systematize and understand this technology, obtaining information of the essential characteristics and principles as well as the main challenges. It has been tried to mention some applications referring to different areas but it has deepened in the area of logistics to be the object of this study. In addition, it will be realized a study of Blockchain, analyzing its main applications and benefits as well as its challenges and disadvantages. With all that, it will be formed an overview on the current state of technology. In this case the keywords used have been Blockchain, Blockchain-Logistics and Blockchain applications.

In the next phase, a SWOT analysis has been accomplished, selecting articles of different themes and authors to obtain the greatest possible number of point views and a broad spectrum of contextualization. In this way it has been tried to observe the strengths, weaknesses, opportunities and threats that Blockchain currently presents accordint to different sources and authors. With this information it will be easier to know how could be the impact of Blockchain in logistics. The keywords used were Blockchain principles, Blockchain and supply chain, Blockchain strenghts, Blockchain opportunities, Blockchain weakness, Blockchain threats and Blockchain SWOT.

The SWOT analysis does not have a clearly defined structure and it is often complicated to organize the most important factors in the four dimensions that are analyzed. In addition, some

factors are explained with too much generality, sometimes not being clear the real application in a specific field. Therefore, it has been tried to be as exhaustive as possible in terms of determining the factors.

On the other hand, due to the immaturity of this technology, it has been complicated to determine the strengths that are currently demonstrated than the weaknesses. However, it has been tried to examine the main strengths and weaknesses in relation to each key problem in the external environment, trying to provide organizations with information and knowledge about this technology.

We have also noticed that some articles treat factors in different ways. Ones are considering some factors as strengths and others as weaknesses as well, depending on the context and the situation. For example, in the case of participation, some articles are regarding as a strength since all members must verify and validate the recorded information. However, it is also acounting as a weakness in other articles as it can not obtain the wished individual privacy.

It is of the utmost importance to mention that personal opinions that were not previously contrasted by other studies have not been taken into account, with the aim of being as rigorous as possible. In addition, no factor has been prioritised according to the articles area.

Moreover, an interview with professionals has been carried out in order to verify the conclusions drawn from the SWOT analysis and the impact of Blockchain in logistics.

Finally it willl be discussed the overall thesis, the main limitations of the work and what is the future works to be developed.

1.4 Structure

The dissertation is divided in six chapters. In this first chaper it is presented an introduction about the thesis which motivated the question being studied in this work and the methodology to be used.

In chapter 2 the differents terms discussed during this work will be explained according to the analyzed literature review.

First of all, it will be made an introduction about logistics, taking into account the activities and processes which form the logistic management. In addition, it will be defined the supply chain management focusing on efficiency and effectiveness as one the most important factors to measure the right functioning of a process.

Moreover, another crucial topic to understand the relevance of Blockchain in logistics is the Industry 4.0 as it is the current industry trend which encompasses several technologies such as Blockchain, Internet of things, et cetera. Therefore, it will be made a contextualization of Industry 4.0 describing the history, key components, challenges and the relation with logistics.

It is also necessary to build a section dedicated to Blockchain as we have to understand what is Blockchain, how works and what are its main applications nowadays. Then is explored the definition, architecture, types of Blockchain networks, challenges and applications in logistics management and suppy chain performance.

In chapter 3 it is developed a SWOT analysis. The main strengths, threats, opportunities and weaknesses of Blockchain must be under carried to know what the pros and cons of this technology are, as well as the current state of development.

In chapter 4 it will be evaluated the SWOT analysis thorught an interview built for getting the opinion of professionals in some sectors. This interview consists of questions with open answer with the purpose letting participants to express their own opinion related with the the asked topics. In addition, participants will have to divide the critical factors about Blockchain into strengths, weakness, threats and opportunities. Finally, the surveyed can express their own considerations about Blockchain and its impact in logistics.

In chapter 5 it will be exposed the final conclusion according to the results of the methodology.

CHAPTER 2 - LITERATURE REVIEW

The second chaper is dedicated to present the pillars of this work – Logistics (section 2.1) and Industry 4.0 (section 2.2). Thereafter, we present Blockchain and a structured discussion on the findings from the literature that provide the basis for the methodology herein presented and implemented.

2.1 Logistics

2.1.1 Introduction to Logistics

During the first section it is intended to provide a thorough understanding of the logistics definition and the role it plays in the supply chain. Therefore it will be explained the term of "Logistics" and "Supply chain" to understand what they are composed and what they are also representing.

Different definitions for Logistics have been published throughout the years but it is considered that the one definition could be "Logistics is one of the parts encompassed in the management of the supply chain and it interacts with the flow and product information along it. Also, it aims to achieve the optimization in all the processes with a minimal cost" (Inda, 2014).

Moreover, the Council of Supply Chain Management Practitioners, which is the main organization formed by professionals in the supply chain, provides the definition of logistics as "Logistics is the activity which have the function of planning, implementing and controlling the efficient and effective flow of services, information and goods between the point of origin and consumption" (Gibson et al., 2005).

That is why there is not only one definition for contextualizing and understanding what is logistics. However, businesses and professionals need to understand the fundamentals and common goal pursued to implement some of the industry 4.0 trends (Bowersox, 2013).

Furthermore, the logistics can be divided into two complementary dimensions: internal logistics and external logistics. The first one consists of planning, managing and coordinating the flow of materials and information that occurs within the company. External logistics tries to perform the same functions but interacting with the several external players involved in the activities and processes, such as suppliers, transporters and even customers.

Nowadays, logistics is not analyzed taking into account separate activities or processes. It is trying to integrate all the activities into a whole process. This way of managing logistics is called integrated logistics (Inda, 2014).
Here, we will identify the main activities in logistics management:

- Supplier Management

- Transportation Management
- Fleet management and equipment
- Materials and inventory management (stock)
- Orders management
- Planning supply and demand

It is found that integrated logistics management (considering all processes related to the supply chain and creating global strategies) increases the overall efficiency and lowers the overall cost, improving lack of information and damage (Pau i Cos et al., 2001). Some of the main advantages are the following (Pinheiro et al ., 2016):

- Reach and meet the needs of customers
- Maintain an overview of the company
- Jointly address all processes and activities related to logistics
- Optimization and reduction of time and costs
- Customer bonding through information technology

Logistics management is considered one of the main factors to think when a company wants to establish and implement corporate strategies. Companies should focus on enhancing their own skills, processes and technologies enabling them to create a competitive advantage (Hollenbeck, 2014).

For this purpose, information systems and industry trends 4.0 are a great ally, providing faster exchanges of information between the different parties involved and improving the properties of transactions (Sandberg, 2013).

2.1.2 Supply Chain Management

The definition of "Supply Chain" could be the proposed by La Londe and Masters. They said that supply chain management includes a set of firms that pass materials forward. Several independent companies are involved in manufacturing a product and placing it in the hands of the end user. This process implies the coordination of raw material and component producers, product assemblers, wholesalers, retailer merchants and transportation companies (La Londe and Masters, 1994).

Moreover, it could also be defined as "the network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services delivered to the ultimate consumer. In other words, a supply chain consists of multiple firms, both upstream (i.e., supply) and downstream (i.e., distribution), and the ultimate consumer" (Martin L, 1992).

Currently, the management of the supply chain is the field where logistics is included. It is the

joint management of all the encompassed processes in the supply chain as well as the main involved players and undertaken activities.

In the Figure 1 it can be observed a basic outline of a supply chain, with the main information flow.

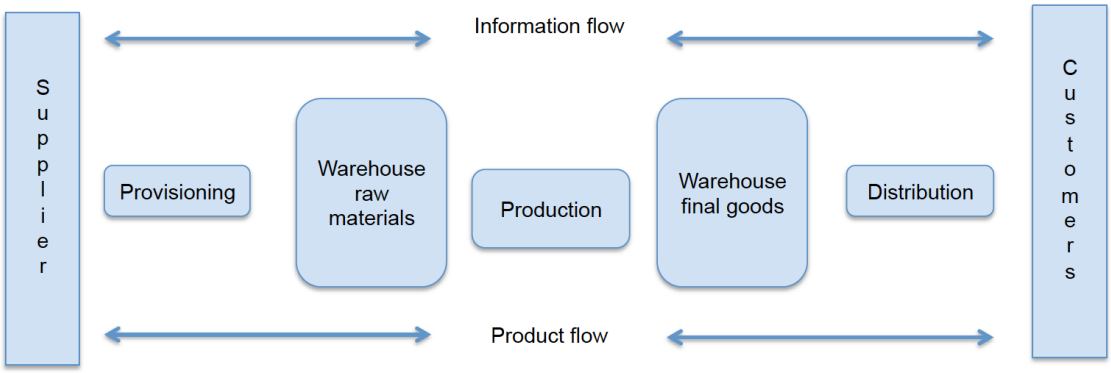

Figure 1. Basic Supply Chain. Source: Basic Manual of integrated logistics, 2014

As it can be observed, an exchange of materials and information is produced from suppliers to customers. Moreover, not only the activities related to logistics management, but it also includes other activities such as production, customer service and performance monitoring. efficiency and effectiveness. These two last factors must be taken into account. Efficiency relates to the optimal use of available resources (Öjmertz, 1998) while efficiency is related to the fulfillment of the main objectives offering and meeting customer needs (Kao and Hwang, 2014).

However, there are several issues and trade-offs regarding how to perform supply chain management. For example, the responsible area for carrying out the production of goods will try to occur in droves, taking advantage of a single process to manufacture many products and minimizing manufacturing unit costs. However, this is a problem for those responsible for managing the stock or inventory level, since manufacturing in large batches produces an increase in inventory, causing a high cost of stock. This is just one example of the trade-offs that can arise along the supply chain (Inda, 2014).

2.2 Industry 4.0

The remainder of this chapter is structured as follows: first, the approach used in the research is to explain the history, definition and components of the industry 4.0. The second part is focused on the key technology which is used, its advantages and challenges, and its application. The third part will the term productivity optimization which is related to productivy improvements. However in the fourth part it is also included the big challenges for Blockchain. In addition, it will be explained how Blockchain could impact in logistics and supply chain. The last part of the chapter will try to give a general approach about all these concepts and innovate trends, this

includes how can they work together and what kind of activities can be developed with them. The work presented may be issued from case-studies and theoretical research with a potential to be applied in industrial aplications.

2.2.1 History

Industry is one of the most fundamental elements of the economy, through which the material goods for society are produced (Schwab, 2016).

To understand the Industry 4.0 an analysis has to be made on the main “Industrial revolutions” popularized as periods of technological discoveries. These revolutions have had a high impact on society.

It is not easy to divide the history in exact periods of time because each revolution has no evident beggining and end. However, many historians agree that it’s undeniable the existence of four revolutions in the field of industry (Klingenberg, 2017).

In this process, the world has experienced three industrial and technological revolutions - currently brewing the fourth- over the last two centuries. Basic enery sources, dynamism and communication have changed in each of them (Freeman et al., 1997).

Following there’s a brief summary of the three industrial revolutions and the factors which have had the greatest influence on each one.

- First industrial revolution (1784-1870). It took place at the end of the 18th century in Britain. The most significant characteristic was the substitution of water, coal and steam power for human labor. This fact helped increasing the production in several sectors starting with the textile industry. Moreover, this revolution yielded the separation of work and personal life, the growth of urban center and the emergence of a proletarian class, as one of their top priorities (Hobsbawm,2016).
- Second industrial revolution (1870- 1969). The United States were its precursors, with the appearance of electricity. Goods became accessible to a large part of the population, which lead to the increase of the living standards. As a results of the advantages, some companies were able to improve their activities and reduce their operating costs (Jensen,1993).
- Third industrial revolution (1969- Today). In this case it’s not about an enery source change. Electronics and information technology had the fundamental paper in this period. Industries started to automate their processes as the technology replaced current activities formerly made by human (Jensen, 1993) (Freeman et al., 1997)

After the first step, which defines and identifies each revolution, the new step is analysing the technical advances, economic situation and demography. The Table 1 defines these factors in each period of time.

Table 1. Cristina Klingenberg (2017) "Industry 4.0: what makes it a revolution?"

Revolution	Technical advances	Economic situation	Demography
First industrial revolution	- Watt steam engine - More autonomy to manufacturing - New machines in textile industry - Mechanization of the tools in agriculture	- Rural manufacturing network - Intense ultramarine trade - Coal availability	- Population start to grow fast - Creation of demand - Amplification of the labor supply
Second industrial revolution	- Effects in railroads, steels and chemical - Development of mass production system - Specialized machines	- Diffusion of industrialization through Europe and United States - Verticalization of the automobile industry - Creation of R&D departments	- Migration of labor - Fast growth of population - Growing demand
Third industrial revolution	- Advanced Manufacturing Technologies (computers, chips, internet..). - Automation of activities in manufacturing and electronics -More customized products - Shorter production cycles	- Investments in R&D by governments and universities - Oil crisis in 1970 - New operation strategies - Manufacturing activities were moving to underdeveloped countries -Globalization intensified the IT application	- Demography changed a lot - Availability of labor - Low wages

2.2.2 Definition and drivers of Industrial digitalization

Nowadays, activities are developed with the presence of technology as a main tool to make them possible. Thus, it is a new way to organize, execute and implement processes in daily life. The largest applications of information technology have changed the organization of business and those changes are known as “the Fourth Industrial Revolution”. This term has become a new paradigm around the world and many people discuss the impacts that it would have in the future (Freeman ans Soete, 2008).

Industry 4.0 emerged as a long-term project driven by the German government as part of the 2020 high-tech strategy action plan. Between the main trends, the evolution of current systems in a productivity approach, the access to information and the use of innovative software programs are involved.

This revolution is based on some characteristics. The first one, is the need of an individualized production that takes into consideration the customer behaviour. The second one, is the horizontal integration in collaborative networks represented by all the organization. Finally, the last one, is the digital integration of the supply chain. These technological advances result in a relevant impact on production and distribution (Brettel et al.,2014).

2.2.3 Components of Industry 4.0

Industry 4.0 is known as "The digital transformation of manufacturing" and involves the use of technologies that can increase the efficiency, quality, safety and ergonomics of industrial processes and infrastructures (Lasi et al., 2014).

In order to explain the application of some trends in the industry 4.0, it is important to characterize the several components included in this project as well as the changes that have occurred and originated its appearance must be first addressed. Therefore, the first step is to define the components of Industry 4.0.

In this study, we will identify and define the main areas that we have take in consideration:

- Digital information: the data collected, processed and analysed from digital information, allows making better decisions and forecasts. This information is manipulated and displayed by computational tools.. In addition, digital information is stored using a series of ones and zeros.
- Automation: In recent years, the automation of processes is managed by machines. Besides, is important to note that it will seek to diminish the costs of possible human mistakes. Automation is being used in several applications of areas such as manufacturing, defense, transport, utilities and operations.
- Intelligent manufacturing: it is a fully integrated flow that synchronizes the production phases, by generating an increase in productivity, performance and

sustainability. Moreover, it has the purpose to optimize manufacturing resources and improve business value.

- Connectivity: the customer is informed and connected all the time, knowing the information required by the product, presenting challenges to suppliers and generating new business opportunities. This conection allows the ability to link and communicate with other computer systems and enabled all employees to discuss team issues in real time.

However, not only technology plays a fundamental role in industry 4.0. The changes have also shaken cultural and organizational factors in the industry based on digitization and connectivity. The effective analysis of data, the use of information systems that allow constant communication between departments of the same company -and even in different companies- and the use of a database capable of storing information, have an impact on the efficiency of the entire value chain. In addition, it has been created a large number of new business models in different sectors in an effort to cover the most demanding needs.

It is expected that in the near future modular manufacturing systems and processes will be created controlling the execution and revising their own activity. Digitization in processes will require a change in the value chain, starting with the acquisition of raw materials until their final use.

This high-tech strategy has implications for the production system, using cybernetic systems, connecting machines, objects and people in real time and offering storage solutions (Bahrin et al., 2016).

2.2.4 Key technology in the industry 4.0

Industry 4.0 offers a new vision based on technology. It will transform the business models, connecting the product to an integrated and transparent supply chain. It can be decomposed in sub-fields of technology as presented below.

- Internet of Things (IoT): It's a system with devices and other everyday objects which offers us relevant information and data for further analysis. Moreover, these devices work with other related devices and exchange the information they get from one to another. Increasingly, organizations in the whole world are using this tool to operate more efficiently.
- Advanced robotics and artificial intelligence: To automate industrial activities, decision making and even learning emulating human logical thinking.
- Systems for vertical and horizontal integration: vertical is understood as the internal implementation of a process or service in a company. On the other hand, outsourcing is called horizontal.

- Communication (Machine to Machine): Known by the name of M2M communication, machines communicate by exchanging information and they can perform efficient actions without the need of human intervention.
- Cyber-physical systems: Are those devices that have computational, storage and communication skills with the aim of directing and interacting with a physical process.
- Big Data: It is the massive analysis of data, which can be processed and stored for issues that previously would not have been possible to solve in the company.
- Hyper-connectivity: Defines the model of society permanently connected to information through different devices.
- Cloud Computing: Consists of a new model of implementation of ICT services (Information and Communication Technologies) connected through the Internet.
- Cybersecurity: It is the practice of protecting the computer systems of the companies from attacks that could put at risk the activity of these systems.
- Digital manufacturing (3D printing / 4D: Printing (height, width and depth) becomes intelligent objects capable of adapting and interacting with the environment or demand.
- Virtual and augmented reality: is the technology that allows us to replace the environment and move to a digital world. In augmented reality sight it is not obstructed, but information is increased by adding relevant knowledge and receiving it in real time.

It is worth mentioning that the incorporation of any of these elements in the company's value chain facilitates the flow of information from the physical world to business decisions in real time (Hermann et al., 2016).

The high capacity for innovation represents one of the greatest success factors in the business world. Another key factor is achieving a flexible production in which non-centralized decision making occurs. For this, it is necessary that the business organization is not highly hierarchical.

Currently, Germany leads the digital transformation and the introduction of smart tools. In recent years, it has been possible to integrate predictive technologies for making decisions, related to the software transformation and the creation of an interconnected cybernetic system. These changes have allowed the use of information on salaries, demographic changes, resource management, efficiency and production (Santos, 2016).

Therefore, data transformation related to Big data must be integrated to achieve an increase in the productivity and transparency of the company. This implementation is made up of several

components combined with the construction of an online platform, built according to different criteria based on the speed of calculation and the complexity of the organization.

This platform is composed by algorithms created from laboratory experiments performed with real data. However, these experiments cannot address a large number of data so they limit the operation of the machine to certain conditions. Therefore, one of the main current challenges is the creation of an algorithm capable of extending the use of the data for which it has been programmed in a wider spectrum. Thus, it will be able to deal with previously unknown situations and achieve a very high flexibility in the operations (Hermann et al., 2016).

2.2.5 Potential improvement areas

The productivity optimization has been achieved by the implementation of the key technologies, previously mentioned. Some examples of productivity improvement that have been generated in the industry 4.0 are included in these areas:

- Integration Systems: Operational technologies have been integrated with information and communication technologies. In this way, progress has been made as the connection of the different areas of the productive unit and the company with all the key players in the value chain as suppliers, logistics personnel and transport and even with customers.
- Additive manufacturing: It allows the design and manufacture of products virtually. It is no longer necessary to make previous molds or prototypes, spending resources and time that can be used in other processes.
- Cybersecurity: It is a fundamental aspect in Industry 4.0. Most processes are performed in the cloud, and therefore, security is a priority. A significant part of data could be sensitive information therefore this system protect it from network attacks.

In Industry 4.0, the machines exchange data and processes automatically. Furthermore, data processing mechanisms must be used in order to make right decisions and to work properly (Bitkom et al., 2016).

Besides, it's important to note that it proposes predictive information as logistics base. This information requires the use of tools that allow us to obtain decisions based on rigorous and truthful data. The implementation of the main trends of the industry 4.0 in logistics helps achieving added value for organizations and society.

Processes based on mechanical systems, need to be transformed to highly automated production lines. Prediction will reduce the time of inactivity and defects correction. Moreover, it will increase the security and it will optimize the management of the different departments,

speeding up the final process. The costs related to energy expenditure will be also reduced (Frieden, 2018).

The new technology can be used to determine the product's performance and its needs, among other fundamental purposes. The influence of Industry 4.0 is reflected by three main points: digitization of production, automation and integration of the entire supply chain (Vešić and Bosch, 2016).

It is important to notice that consumer behaviour has also varied. The currently growth with the adoption of information systems and the massive expansion of information through social networks have been the factors that have transformed the way the consumer behaves (Brettel et al.,2014). More specifically focusing on the quality, the variety and the personalization of the product.

2.2.6 Challenges

Industry 4.0 not only will bring benefits for companies, but it will also have to face some challenges before the revolution become a reality. It requires the collaboration of all the members in the value chain. Moreover, it will not have benefits if the company doesn't believe and invests on it (Lee et al., 2015).

However, many systems are not ready to address the introduction of smart tools. For this reason it is going to be carried out an in-depth study on one of the main trend that are integrated in industry 4.0, blockchain and its impact in logistics.

Nevertheless there are other issues that need to be solved for the development of the industry 4.0 in logistics. Autonomous computing methodologies have been implemented, obtaining benefits in time and cost. However, self-learning machines are still a task to be solved in the industry. In order to be able to implement them in current systems, a huge study should be made in the current logistics. The main problems to be addressed according to their origin and implementation are the following.

Interaction and communication among the different employees who operate a machine must be facilitated. On the one hand, administrators design and integrate mathematical programs, and on the other hand, operators are responsible for controlling the operation of the machine once these programs are applied. In this way, the machine only is assigned by one function, without any notice of failure or incapacity in any component.

The same type of machine is used to make completely different tasks. This fact causes problems in the systems of prediction as they are programmed and designed for specific operating conditions. To solve this problem and decrease the number defaults in a production

chain, different and specific controls should be stablished. As a result, the implementation cost would be increased but the information cost would be significantly reduced (Kagermann et al., 2013).

In addition, another way to determine the correct operation of the machines is to collect information about the quality of the final product. If there are deficiencies in the quality of the final good, there must be control points and methods that verify where the fault is produced. These control points and methods would be integrated by sensors as well as other control devices.

As mentioned above, the use of big data and the cloud is being one of the main applications in current business. It is the main tool to create machines capable of self-correcting, with self-determination and high efficiency. Nevertheless, a complete integration between the operator and the machine must be developed. The ordinary machines are only dedicated to fulfil the original programmed orders. It is expected that in a few years the machines will be able to react when the assigned task is not going to be satisfactorily fulfilled or the required conditions are not correct.

The real efficiency of the system can be affected by the reduction in operational output or the constant stoppages due to system failures (Khan and Turowski et al., 2016). It will be necessary to carry out an analysis of the main resources to visualize where is the bottleneck and how affects the entire production. The bottleneck can be caused by several factors, including excessive workload for a single machine or the inability to achieve its function.

However, not only the machine is responsible for obstructing the correct operation process, but also is the lack of knowledge or ability of the employees to adapt to the Industry 4.0 in the area of logistics. These employees must be trained to obtain the necessary knowledge to develop a thought based on digitization, autonomous decision-making and problem-solving capacity.

In this way, the application of industry 4.0 to the current logistics cannot be summarized only by digitalization and automation of processes. It is also necessary that the organization and the supply chain work together. The professionals will have to adapt to the new requirements and be able to deal with the new emerged problems (Kagermann et al., 2013).

Another crucial aspect is the security in privacy data, given that cyber theft is one of the main problems of using internet. We must create reliable systems Reliable systems must be created so they can't be invaded by these information thieves.

It should not be less important to take into account the number of devices connected to the cloud and the interaction between them. The protection of data requires the creation of specific

mechanisms to safeguard the privacy of the global environment. Therefore, it will be necessary to collect data with total transparency between the company and the client.

In addition, the implementation of information technologies requires an initial investment that could be a huge amount of capital (Kagermann et al.,2013). Each company will have to analyse if introducing the logistics mechanism related to the 4.0 industry will be profitable in the final result. Therefore, each specific case will require different conditions and investment according to its characteristics.

Finally, the standardization is another change for the industry 4.0. The system must generalise its features for the various industries and markets. The aim is to create a system capable of taking advantage of the economies of scale and generating data in different formats (Lee et al., 2015).

2.2.7 Impact in logistics and supply chain management

Logistic management is made up of all the mechanisms that meet the needs of customers through the organization and coordination of all the activities and processes that make up the supply chain. In addition, it also implies activities related to the processes of production and distribution of goods (Lee et al., 2017).

With the aim of improving current logistics there has been a high development in technology based on three fundamental pillars: information, communication and automatic identification. These pillars are advances in innovation, speed and ease of processes (Porter and Heppelmann, 2014).

The automatic identification consists of the introduction of data directly into the computer system with the use of logistic controllers or microprocessors. The three most common forms of identification are radio-frequency identification, bar coding and speech recognition. This technology is used in the field of logistics in many applications, such as data storage and processing or in the tracking of goods during distribution. In addition, automatic identification is also used during the production process.

The products are identified in each of the phases, knowing their degree of development by assigning a bar code, elseway and once the productive process is finished, the product is transported to the warehouse. During this transport, it passes through a conveyor that scans the product information and registers it I the data center.

Likewise, these technologies improve the ability of manufacturers to estimate the volume of inventory (Kagermann et al, 2013).

Another technology used for transfering information between organizations is EDI technology, based on the transfer of documents or transactions from one software to another software, that is, from one computer to another. In this way a higher volume of transactions can be achieved in a reduced time, and the transaction cost is reduced by being an online service, which improves the commercial relations between the different organisms of the supply chain.

Finally, recently, the use of web services by companies has been extended to a service called "Web based Tracking". Through this, customers are able to visualize the trajectory of their order, from the warehouse to the moment of delivery (Raghuram and Nahgaraj, 2001).

2.2.8 Innovation trends and proposed systems

To provide a high quality and speed in the delivery of the products it is necessary that the logistics systems of distribution has specific characteristics based on the capacity of prediction, comparison, reconfiguration and maintenance (Roblek et al., 2016).

Another of the identifying and differentiated features of logistics in Industry 4.0 is the intention to improve and optimize the service for the customer. The aim is to combine production, distribution and customer service in order to improve product competencies. For this, changes have been made in the way of "offering value" and integrating value to the product. One of the key tools is the creation of a cloud-based platform that contains an infrastructure designed to offer solutions to different consumer problems. The companies not only focus on the sale of the product, but also on satisfying the needs of the client.

In addition, there has been the creation of a unified information network that connects the system with customers instantaneously. This strategy uses recent and past information to provide adaptability to the new future situation.

In this way, the relationship between the consumer and the producer becomes closer. Sellers get feedback from consumers who evaluate and value the service received, but at the same time, consumers value fundamental aspects such as the quality and reliability of the information received. Additionally, it is clear that this trend leads to greater individualization of the products. With all this, there will be an improvement in logistics with a common goal: to collect data that allows analysing the environment by integrating it in a circular economy that allows to reduce expenses and increase revenues.

Thus, one of the main tools used by Industry 4.0 is called the "Internet of things", that represents the integration of all the intelligent devices that are part of the main platforms. Through this tool, market business models have been transformed by increasing the supply of goods. In addition, the supply chain strenghtens its efficiency by obtaining more detailed and updated information.

Artificial intelligence and augmented reality are also trends which are transforming the way of doing. Thanks to the great degree of automation and the capaciity of predict operations logistics can remove tradicional models and create opportunities for new services.

Moreover, cloud computing is another tool used by companies to create a platform where internal data would be available and easily managed. Most importantly, it can also minimize the associated problems with descoordination or lack of knowledge. Therefore, many business have noticed the growing need for creating their own digital platforms providing visibility and dynamic communication.

However, it will be analyzed one trend which is called "Blockchain". The main reason is because this technology is not completely mature and there are many ssumptions about it but without any verification. Thus, it is necessary to understand what it is about and how could improve logistics (Lee et al.,2015)

The new business models must adapt to the constantly changing human needs, always respecting the rules related to privacy. Therefore, designing business models that include internet and connectivity in processes is one of the bases of current logistics. In addition, digitalized environments that have virtual simulation and response as an engine will provide solution scenarios to the various problems that have arisen (Heutger, 2018).

2.3 Blockchain

During this section it is conducted a study on the Blockchain as an emerging technology and thereafter how it can impact on the logistics sector.

First, in the definition and the architecture of Blockchain, it will be analyzed the evolution over time of blockchain, specifying its characteristics and similarities with other technologies. In addition, it will be explained the main types of networks and the applications of this technology, in general and in logistics, as well.

Subsequently it will be discussed the current state of this technology and the presented opportunities, namely by analysing if it is experienced enough to be applied in different sectors with low risk on the outcomes.

In addition, it has to take into account the claims of its limitations and adaptation to the different processes of its principle applications. Therefore it will be analyzed all this information in the paragraph dedicated to challenges.

Given the relative newness of the concepts, it will be intended to provide an overview of the topic and its main features and applications in the area of logistics.

Finally, giving an overview of the results, providing an overview of this technology and comprehensive knowledge of its details.

However, future research should examine other factors such as industry trends, the pressure from governments or degree of management support and factors that influence the implementation and impact of technology.

2.3.1 Definition

Blockchain is referred to as the system that enables decentralized data storage and transfers it without any other intermediary system. This is an emerging technology developed for use in a wide range of applications and industries.

It consists of a record of digital transactions using ledgers distributed beyond the control of centralized organizations. It aims to eliminate the risk associated with intermediaries, instability and even interruptions of privacy. It also seeks to end piracy as it is able to track all transactions (IBM, 2017).

Thus, it is unlike the traditional databases because it does not rely on intermediaries to verify control operations and it is able to operate between various stakeholders. In fugure 2 it can be observed the information flow in a general supply chain.

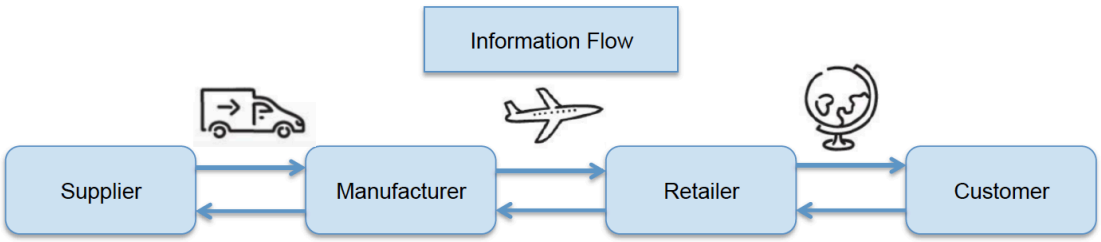

Figure 2. Information Flow in Suppy Chain. Source: Adapted from Mapping the Sea of Opportunities: Blockchain in Supply Chain and Logistics, 2018

Since the advent of Bitcoin in 2008 and its rise on different platforms, the Blockchain technology has generated interest in many social groups (Nakamoto, 2008). In fact, in 2016 technology companies and service providers invested more than one billion dollars in their business to introduce Blockchain in various processes, an amount expected to increase in the coming years (Harty, 2018).

Before performing an analysis on Blockchain it is required to find a suitable research protocol. During this process, it will be gathered research from papers and authors, focusing our search on the Web of Science database. The papers have been filtered using some keywords: blockchain, blockchain and logistics, Blockchain and supply chain and blockchain and applications. In addition, the papers have been selected with the aim of not only analyzing the

development of this technology over time, but analyzing the current situation. Therefore, several papers have been extracted from previous years until now (from 2014 to 2019).

The Blockchain technology triggered the evolution of Bitcoin cryptocurrency. A dramatic increase in the price of Bitcoin for a short period of time generated interest from many investors and entrepreneurs. Bitcoin can be defined as a public, open, decentralized and anonymous network. The transactions do not require personal information because the system is able to trace the activity associated with each of the accounts (Hackett, 2017).

It was in 2015 when Blockchain became known in the financial sphere, and later began to expand into other areas, including logistics. The change involved adopting this concept in the industry was not easy to assimilate, however, instead of it being a gradual change a more instantaneous introduction into the various areas of application was more applicable (Pilkington, 2016).

Furthermore, Blockchain is considered as a database organized as a list of blocks connected to each other. There are three generations of Blockchain: the first one was used to launch the digital cryptocurrency transactions. The second generation was based on the usefulness of this technology by addressing other related supply chain fields. Currently the third generation, has various applications in different areas using smart contracts, accelerating transactions by optimizing consumed resources and improving security (Zhao et al., 2016).

However, according to recent studies, one can conclude that this system is not yet efficiently integrated into companies, mainly due to ignorance in some sectors. Its applications in sectors such as logistics, still generate controversy and uncertainty. Many companies are not familiar with this technology and are not aware of its potential (Kersten et al.,2017).

On the other hand, one of its main objectives is transparency in data. All members belonging to the same network have the right to display the content that has been introduced into the network, without any distinction. This way, it creates reliable and verifiable systems within an organization or for sharing data between different organizations.

Another main benefit of blockchain is to reduce transaction time (by not using intermediaries), improving visibility at all stages of the supply chain, through increased transparency of the process, and improving communication between members responsible for activities to be updated and instant information at all times. It is true that the benefits of this technology will not be fully ascertained until it reaches maturity and consolidates companies to invest in this technology for their processes (Min,2018).

In table 2 is shown the main principles of Blockchain.

Table 2. Blockchain Principles Source: Adapted from What to adopt and Where to Start,2018

Principles	Definition
Distributed Database	Each party on a blockchain has access to the entire database and its complete history, i.e., no single party controls the data or the information and every party can verify the records of its transaction partners directly, without an intermediary.
Peer-to-peer Transmission	Communication occurs directly between peers instead through a central node, i.e., node stores and forwards information to all other nodes.
Transparency with pseudonymity	Every transaction and its associated value is visible to anyone with access to the system, i.e., each node or user has a unique 30-plus-character alphanumeric address that identifies it. Users can choose to remain anonymous or provide proof of their identify to others when transactions occur between blockchain addresses.
Irreversibility of Records	Once a transaction is entered in the database and the accounts are updated, the records cannot be altered, because they are linked to every transaction record before them. Various computational algorithms and approaches are deployed to ensure that the recording on the database is permanent, chronologically ordered, and available to all other on the network.
Computational Logic	The digital nature of the ledger means that blockchain transactions can be tied to a computational logic and can, in essence, be programmed, i.e., users can set up algorithms and automatically trigger transactions between nodes

Despite the benefits presented by the technology, there is disagreement on what should get implemented globally in the industry. Therefore, during this work it will be aimed to do a thorough analysis of the characteristics of this trend, application and potential impact, generating an overall framework for logistics management linked to the possibilities presented by Blockchain (Banker, 2017).

2.3.2 The architecture behind Blockchain

Blockchain is composed by chain block which consists of different modules that govern the operations and mark patterns of system behaviour. Below we explain each chain block and its typical architecture displayed on a general level, which is represented in Figure 3.

First, the data source module (1) is responsible for creating and coordinating shared databases, thus creating a decentralized network able to operate together. Within this module you can only read and review data but not update or delete it.

It also creates access to databases without permission from any authority other than the user provided obligating all participants to check new additions, thus decreasing the risk of altering the original content.

The second module is the module or value exchange transaction (2) between buyer and seller. During this module, transactions are verified and new ones are created. For this to happen it is necessary for an agreement between buyer and seller to later verify and transfer it to the network. Often different multiple entries are included in the same transaction (Ray, 2017).
On the other hand, the data recording is done permanently in the module creation through files called blocks (3). It may be that a block has to be linked directly to other blocks, in this case a chain block originates a new transaction by mathematical puzzles by adding the log of past transactions. In addition, to ensure the elimination of corruption, Blockchain has created a mechanism called module consensus (4). This complex test work or consensus algorithm tolerance is used to validate each transaction.

Finally, the connection module and interface provides real-time information on the status of transactions, the origin and recipient. Thus, Blockchain coordinates the web interfaces between different users by integrating all applications with their corresponding algorithms. That is why it represents the ideal tool to share data across different organizations or different departments within the same organization, increasing the capacity of association and communication (Min, 2018).

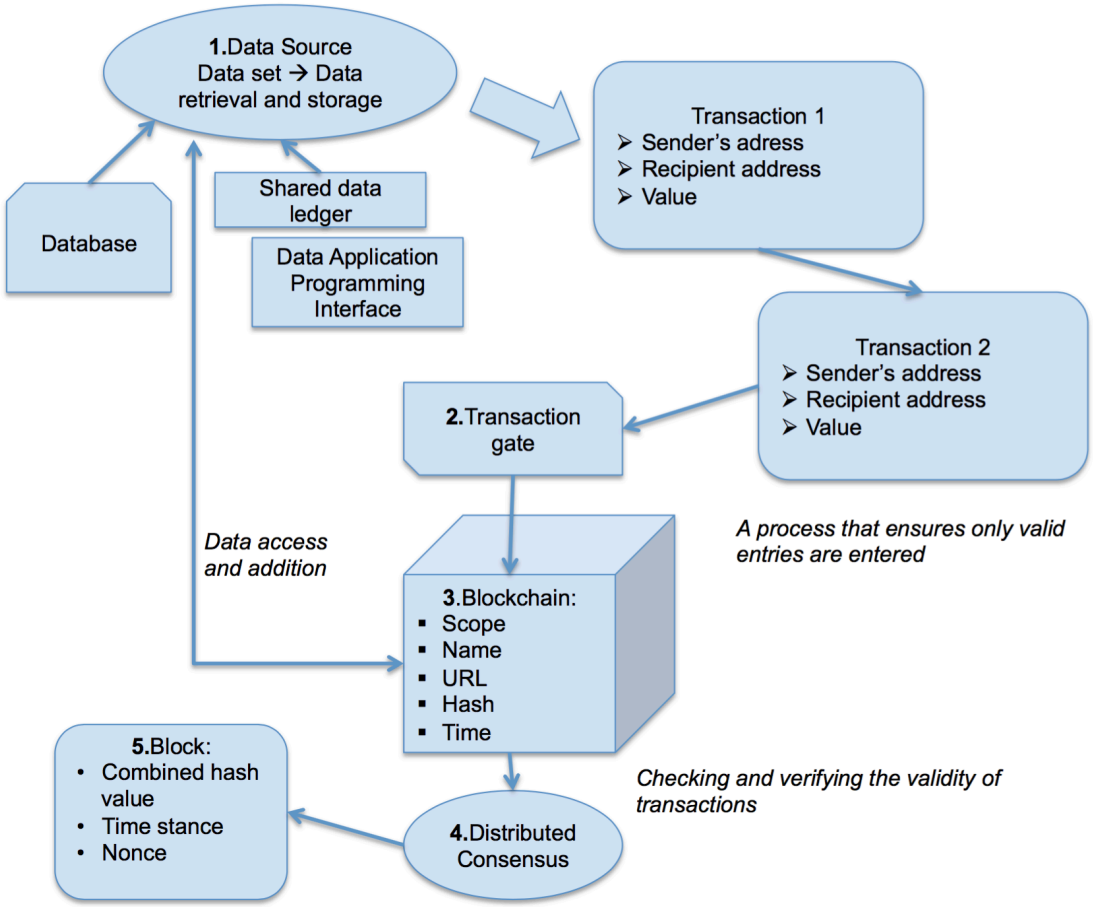

Figure 3. A basic architecture of Blockchain Technology. Source: Adapted from Blockchain technology for enhancing supply chain resilience, 2018

Blockchain enhances interoperability between the various systems and provides a single source of truth and trust. These features make Blockchain to possess a high processing capacity in different scenarios and operations. It also represents a fundamental change in relation to traditional systems, as participants no longer need a central authority for regulation and control. Lastly, it is a tool that may change business models, diversifying traditional forms used in logistics through various initiatives (Minsait, 2018).

In figure 4 is represented the basic inner of Blockchain technology.

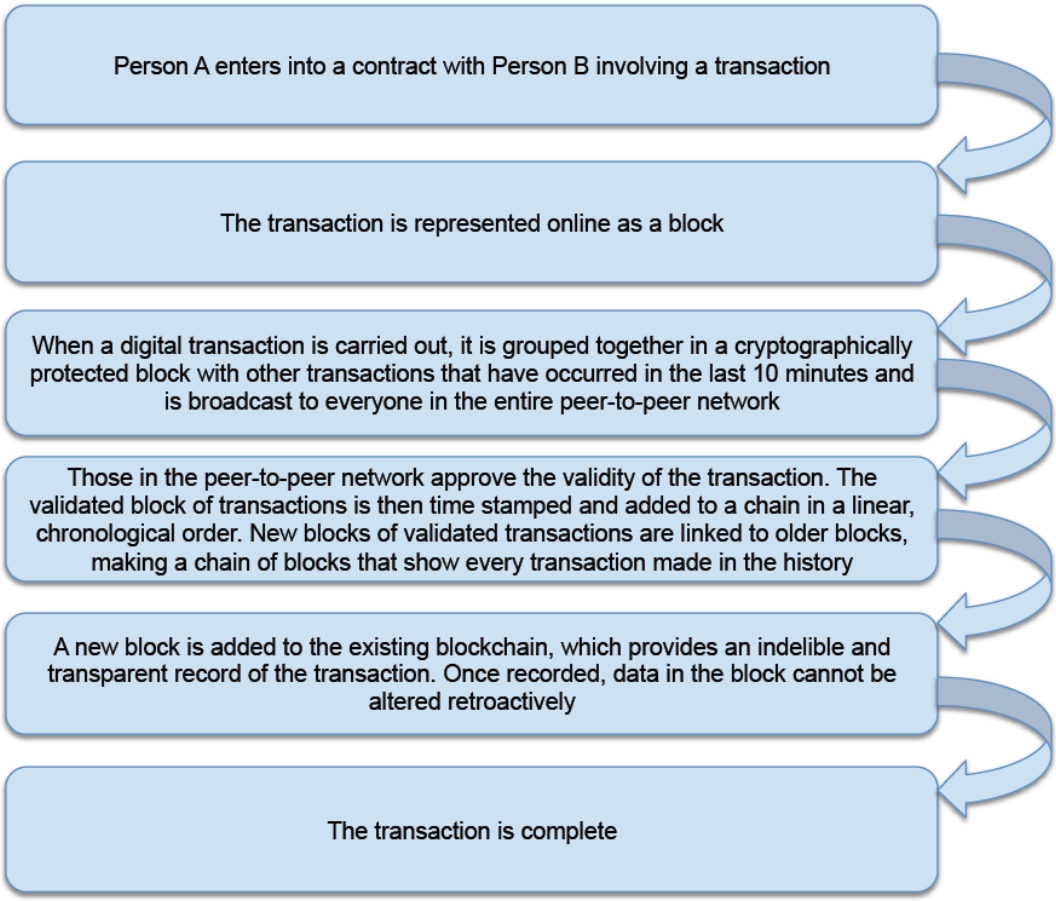

Figure 4. Basic inner of Blockchain. Source: Adapted from Blockchain technology for enhancing supply chain resilience, 2018

2.3.3 Types of Blockchain networks

There are different mechanisms of consensus and exchange of information (Buterin, 2015), which originate three types of networks: public, private and federated.

Blockchain as a public network allows anyone at any time, as well as access to the information platform. Thus, the platform itself is self-managed reducing costs and maintenance administration. The public network is open to any participant space while the private network requires approval to enrol. Bitcoin and Eyherum are types of public networks. They have a lower speed, because they distribute information in countless open and public users books, contrasting to speed of the private network which is faster as it is limited to a number of members (Haferkon et al.,2015).

Furthermore, private Blockchains are only available to the number of participants that interact with the system and create changes within. They are used to further enhance security by

restricting access to certain participants. The main applications offer data management and auditing. This approach seems the most appropriate in the business world, where they have to constantly deal with confidential data. However, an analysis of the specific case which ensures the ideal interface must be conducted.

The basic difference between these two types of networks is the restricting access to the network and sharing data with other participants (Sadouskaya, 2017).

In addition, there is also a federated network, which is a combination of public and private networks. In this case, the level of privacy protection is very similar to the private network, but a set of nodes are responsible for verifying the transaction processes. This way not just a set of users can enter or change data, but they can also give permissions to other external users to perform these functions well. An example of this use is found in the banking and industrial sectors (Zheng et al., 2016). Table 3 summarizes the main properties of each network.

Table 3. Classification and main characteristics of networks. Source: A systematic literature review of blockchain-based applications: Current status, classification and open issues, 2018

Property	Public	Private	Federated
Consensus Mechanism	• Costly PoW • All miners	• Light PoW • Centralised organization	• Light PoW • Leader node set
Identity Anonymity	• Anonymous	• Identified users • Trusted	• Identified users • Trusted
Protocol Efficiency & Consumption	• Low efficiency • High energy	• High efficiency • Low energy	• High efficiency • Low energy
Immutability	• Almost impossible	• Collusion attacks	• Collusion attacks
Ownership & Management	• Public • Permissionless	• Centralised • Permissioned whitelist	• Semi-Centralised • Permissioned nodes
Transaction Approval	• Order of minutes	• Order of milliseconds	• Order of milliseconds

To achieve the integration of this technology in everyday life mechanisms by identifying users

and verifying the correct ones which are needed, it is necessary to create platforms certifying basic features, as well as names, age or other relevant personal information (Lemieux, 2016).

The main objective is to provide the exchange of secure and auditable data in different contexts, situations or processes using intelligent devices connected to exchange information simultaneously. In addition, the technology has been recognized to be in Blockchain favour by giving visibility, optimization and forecasting in logistics chains (Zhang et al.,2017).

2.3.4 Applications

Blockchain has various applications depending on the scope and specific use in that matter, as it can be seen in figure 5. For example, this technology owns a verification system which could improve privacy and security.

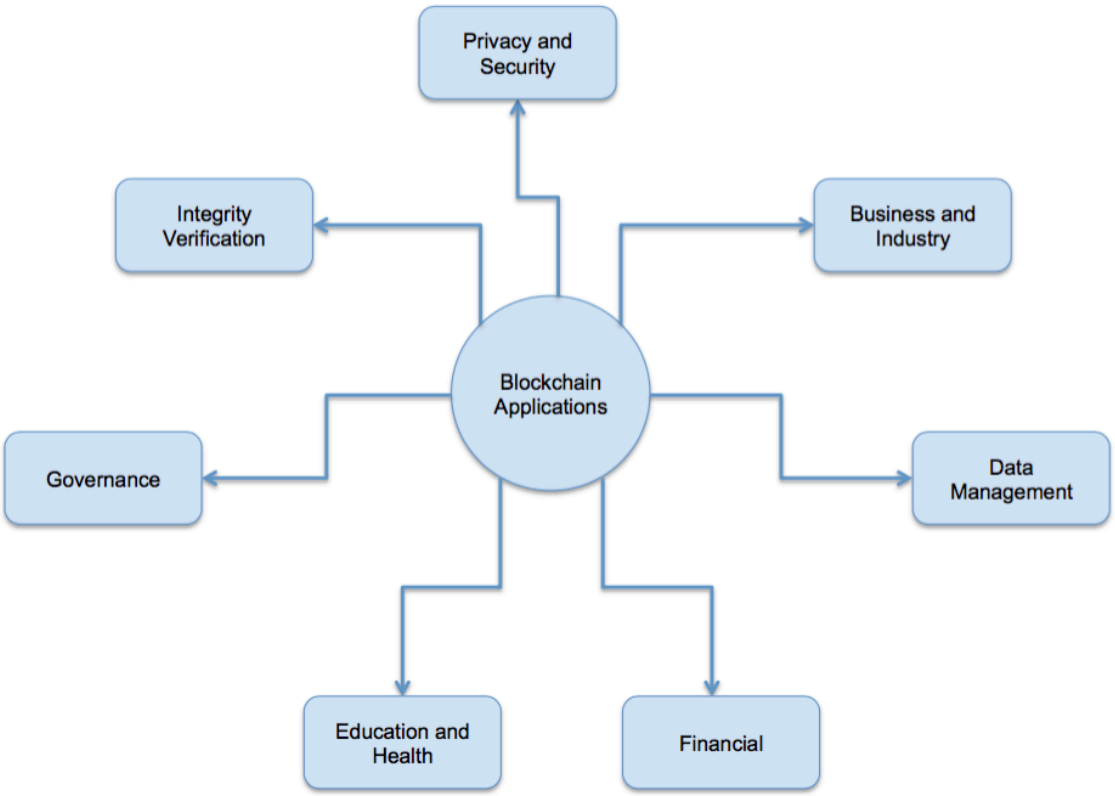

Figure 5. Different types of Blockchain Applications. Source: Adapted from A systematic literature review of blockchain-based applications: Current status, classification and open issues, 2018

Moreover, financial services could undergo innovations with the implementation of new model business. Therefore the data management would become easier to manage and transactions would be faster. Education and health would also be influenced, trying to get a database with

the purpose of providing and managing patients and coordinating the activities. In addition, Blockchain could contribute to create new applications in governance as a transparent database. However, it will deepen its applications affecting the logistics sector which is under study.

In technology, this system it has reached its ripening season, but there are many solutions proposed at a corporate level for its fast growth, focusing on privacy and security increased performance. Which is why it will be intended to analyze how companies can pursue their goals and select the most suitable technology according to their type of business.

The field of logistics is expected to get a short-term move from a technology start-up phase to a technology that allows it to be implemented efficiently and gain a competitive advantage. However, it is necessary that organizations and their relationships are redefined by establishing joint cooperation projects with the objective to progressively implement this technology (Friedlmaier, 2018).

In addition, the technology incorporates Blockchain operations to define the upcoming operational level of the Internet, where not only digital but also assets or money information will be transmitted continuously. This way, the innovative capacity available could mark a breakthrough in today's society.

One of the main applications of this technology is the ability to track the product. During the entire process which is carried out in the supply chain, it is necessary to know the state and location of each of the products. This facilitates advance of unexpected changes due to program errors automation, handling errors or lack of coordination in the manufacturing steps. On the one hand the recording of data allows obtaining accurate reactions to changes and it provides a data network common to all members involved in the organization. In addition, monitoring can restructure the supply chain making it a more agile to constantly updating data in real time (del Castillo, 2017).

The introduction system that integrates referring to assets is immobile unless the owner alerts of a change in any of its properties or state. Thus, with Blockchain you have a public accounting record tracks which records the whole process of the asset, since its introduction in the early stages of the chain to the final destination, drastically reducing the introduction of counterfeit assets (Higgins, 2017).

Furthermore, it can also track shipments, for example in the case of a distributing company, decreasing the possible tampering in transit shipments and increasing transparency (Min et al.,2014).

This technique achieves a significant increasement in consumer confidence. Traceability occurs in the supply chain by which the consumer is able to observe the various stages and intermediates with the consumed final product. This can be visualized during activities from production stages and operation to the storage and preparation areas. Therefore, a greater service delivery to customers is guaranteed.

Moreover, the system of customer orders can also be affected, becoming more efficient at any time to observe its condition and the point that is being processed. Displaying the route orders and history until the arrival times can be performed as an analysis on the average time it takes to produce an order and the level of stock necessary to meet the demand (Hackius, 2017).

The scope of supply chain finance is the field which has more ambiguity and uncertainty. This is the optimization of capital among members of a supply chain with a quick and safe transfer. Thus, the cost is reduced by transaction and security guarantees payments. However, foundations of privacy and security for companies must be defined to show a reliable attitude towards the system (Hofmann et al.,2017).

One of the main risks of disruption in any of the stages of the supply chain is disputing between different members or misunderstandings, difficulting the supply and can even hinder the normal course of activities (Szabo, 1997). Therefore, another major application that Blockchain has is the creation of the so-called intelligent contracts formed to facilitate and verify the starting conditions and compliance requirements by incorporating clauses. It is a computer method used to lay the foundations and automate the execution of predefined rules. In addition, they allow a completely transparent exchange of capital or shared added value without the need for a manner of intermediary arrangement. This reduces the costs associated with the transaction (Icertis, 2017).

These contracts are executed autonomously and automatically by themselves, beyond the control of another person. People involved decide the terms, conditions and to do the same under contract. Through them, creating collaborative ecosystems with great opportunities in trust models will be achieved.

In addition, Blockchain has also extended its applications to other areas, mainly insurance companies. These companies use technology to process customer registration and making claims and payments. An example of the implementation of this technology and current relevance, is the implementation of a program called B3I by many insurers in Europe. The program includes general rules of use and possible applications in the sector (Cognizant, 2017).

It is also possible to run vital operations in the field of health. Some of the applications could be public management, patient registration, tracking the research done to each patient and

organizing queues formed during the wait for the examination (Deloitte, 2016).

Another key aspect to be addressed here is the ability of transparency that can be achieved with the use of Blockchain technology. Therefore, the governments initiative for responsible management and recordkeeping could be raised by introducing this database in their processes. It is vitally important to address this issue, since the security Blockchain can offer an end to corruption and make public services more transparent. It aims to provide quality services in a decentralized manner (Reijers, 2016).

Table 4 summarizes the main specific areas of blockchain applications with the features and impact what it produces in them in some sectors.

Table 4. Specific areas of Blockchain Applications by sectors. Source: A systematic literature review of blockchain-based applications: Current status, classification and open issues, 2018.

Area	Application	Features	Impact
Financial sector (payments)	Creating a network for the distribution of a payment ledger	• No need for central authority • immutable and reliable • Transactions • Each participant has a copy of the ledger	• Increased speed in transactions • Increased transparency • Cost savings • Creating new business models
Industry (International Trade)	Connectivity and data sharing between all interested parties	• Using Smart contracts • More agile operations • Improved communication	• Improved Auditability • Reduction of litigation (single source of truth)
Automotive	Reliable registration where all activities are shared in the lifecycle of a vehicle	• Platform for collaboration between different parts • Monitoring process accurately • Access to historical vehicles	• Reliable Register • Improved decision-making capacity • Progress in coordinating the supply chain • Value-added service to consumers
Insurance services	Shared platform for the entire industry	• Automatic information processing (complaints / requests ...) • Sharing information • Check	• Detection of fraudulent patterns • Detection of claims and behavior patterns • Empowering customers in data management

2.3.5 Blockchain advantages in logistics

Logistics management is an essential part of the supply chain where all processes meeting the needs of customers are integrated. Currently it is known for its key role in managing such technology optimally and improving its overall performance. Therefore, companies should know how to apply the latest techniques in their processes. Figure 6 shows the main advantages of Blockchain in logistics.

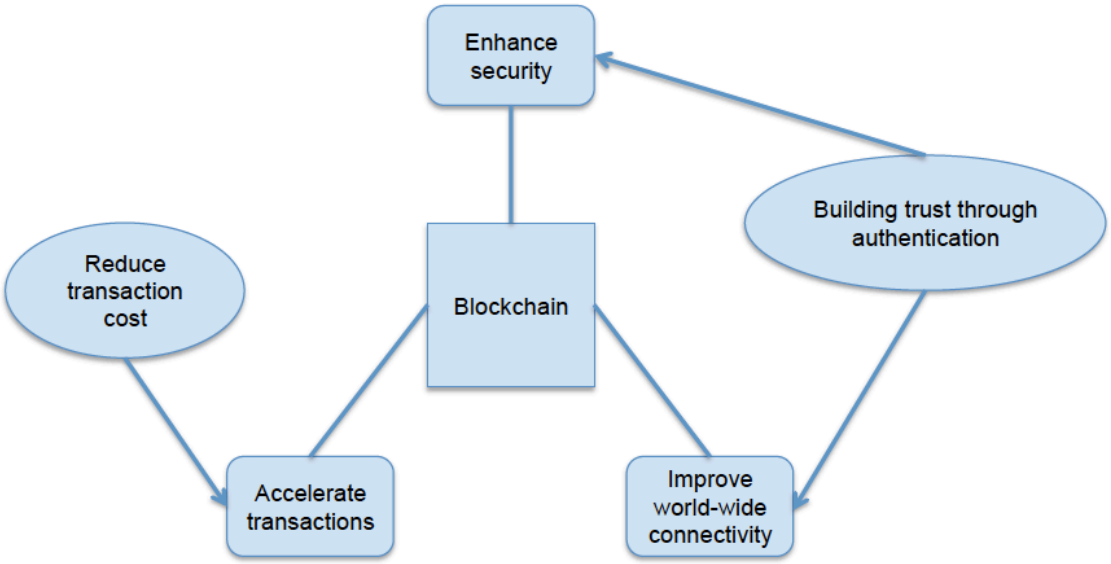

Figure 6. Blockchain advantages in Logistics. Adapted from Blockchain technology for enhancing supply chain resilience, 2018

Many of today's companies have coordinated activities around three types of technology: information, communication and automation. However, it is necessary to know what impact they produce and how to deal with the problems encountered.

The application of the techniques is not an easy task. To understand the functioning of the supply chain is necessary to unite all the stages that make up the delivery of the product to the customer. Moreover, not only the manufacturing and distribution stages are crucial to achieve high efficiency in the company, but also the quality of the product should be optimal and delivery time previously agreed. Therefore, good coordination and organization of work in the workplace is essential, while developing tools to address the proper functioning of crucial issues.

One of the strategies used by companies using this technology is creating a competitive advantage over other companies in the sector. However, caution must be taken for the introduction of differentiation in any of the characteristics of the service or product. They should analyze the availability, production capacity, economic impact and selecting the right technology to achieve favourable results.

During the selection of suppliers, it is necessary to analyze the spectrum and variety of providers available, their characteristics, requirements, capabilities, opportunities and services offered. With the introduction of information technology electronic recruiting has been made possible, where recruiting happens through online auctions and laying strategic relationships with strong foundations. In addition, the introduction of Blockchain would provide a database with information related to suppliers as well as the essential features and offers, therefore, speeding up the process of selecting suppliers optimally.

Furthermore, the technology can be used through online platforms designed for collaborative systems between the different stages of the chain and its respective members. Workers will be able to share information instantly, streamlining the process and ensuring the establishment of good final service forecasts.

In addition, warehouse management is another major use of information technology. The systems created to visualize the path of the goods, obtaining at all times an overview of the process and accuracy in product distribution (Bhandari, 2014).

However, to analyze the benefits provided by Blockchain in logistics management we must first conduct a study on all procedures enshrined within it.

Logistics involves all activities that will satisfy customer needs, obtaining a final product with a quality, condition, time and certain cost. Therefore, it manages the supply chain processes since the adoption of raw materials to be delivered to the final destination. In practice, the timing of the various stages is a complicated task, many workers and areas are involved, and any change may cause delays or defects in the final product (Shapiro et al.,1985).

Blockchain helps to solve this problem. The transfer of information helps both the initial planning stages, providing information on the level of inventory and orders, as well as the final stages, like knowing the status of a shipment, for example. The information needs to be constantly updated for those involved to be able to know in real time the status of the shipment and share information around a standardized interface, therefore, increasing customer satisfaction (Hoberg and Alicke, 2017).

In the current logistics, registration of all actions produced in the supply chain is a vital activity in the process, performed privately in every company and with centrally restricted access to data (Friedlmaier, 2018).

It is expected that Blockchain technology impacts progressively logistics, since many experts believe that it could cause an advance in the way of operating in the supply chain as it can solve friction caused by delays in processes and improve overall efficiency (Hackius et al.,2017).

However, there are many expectations and very few connoisseurs of the platform, logistics being one of the sectors most responsible have little or no knowledge (Kersten et al.,2017). In addition, not only it is crucial to understand the use of this technology but also the ideal application field as business managers may not have adequate knowledge. Therefore, It will be necessary to establish a structured framework to provide with valid information to understand the possible scenarios of application in the current logistics of Blockchain, categorizing applications and displaying innovative business opportunities.

It is intended that managers are able to visualize the benefits produced by this system and serve as a justification for capital investments in it. Therefore, it will perform based on the "framework attribute innovation" by Rogers that determines whether an innovation should be adopted as the resulting benefits and around the five key factors analysis: relative advantage, compatibility, complexity, capacity treatment and observation. Unlike complexity, the remaining attributes must show a high rate in order to establish an adoption of efficient technology (Rogers et al.,2017).

As for the relative advantage it is expected to be based on a differentiation from traditional systems based on the lack of transparency and centralization of processes. Furthermore, the ability of current tracking logistics systems is not clearly defined and the adoption of Blockchain a common framework of information could provide clear visuals of all stages and states through which the product or goods pass through (Korpela et al.,2017). Another key factor are creators of a relative advantage which by adopting Smart contracts are able to reduce or even eliminate the costs associated with the transactions (Giancaspro, 2017).

Also, Blockchain system would provide greater compatibility with current needs as customers themselves would be able to visualize product tracking and delivery of future end-to-end supply chain, reducing the risk of forgery or manipulation (Hackius et al.,2017).

However, despite all the above benefits, the complexity of this system is high, and the bases are not yet clearly defined hindering a common conceptual understanding between all parties, and in general society. In addition, the immaturity of technology and lack of practical cases cannot empirically assess the impact caused. Therefore, a need for a study conducted on how to analyze using current data and studies is needed (Di Grigorio, 2017).

In order to observe the consequences that this technology can potentially cause Iansiti and Lakhani analysis, the implications of organizations based on the novelty and the coordination effort which the application of new methodologies requires. As it is evident, the greater the novelty in society the more increased coordination effort is require, involving the creation of legislation in line with the new features (Iansiti, 2017). Table 5 shows the attributes of innovation presented by Iansti and Lakhani.

First obtaining pilot testing is one of the initiatives that help companies visualize the possible potential Blockchain in their processes, creating an internal database for transactions and verifying identities. This may be an optimal solution for companies in which intensive data handling is involved. In addition, technology allows us to know the location of consignments or transport of goods on a large scale. Another major application of this technology could be based on performance tracking fleet vehicles of a company, where anomalies can be seen and delays can be caused by the type of vehicle, route, the optimizing of the time and associated costs (Heutger et al.,2018).

A report by Gartner estimates that by 2020 there will be over 20 billion of people connected, but the current Internet architecture might not be able to handle all this information without faults occurring in the system continuously. That is why not only the Blockchain technology must undergo a consolidation, but also other industry-related trends like 4.0. This point will be discussed further down this thesis. However, Blockchain could help logistics become one of the most promising fields in terms of adoption of new technology, consequent fields and new business models (Gartner, 2018).

Table 5. Attributes of innovation. Source: Adapted from Blockchain for and in Logistics: What to Adopt and Where to Start, 2018

Attributes	Definition
Relative advantage	The degree of perception that an idea is better than current practice. This could be measured in economic or social benefits, convenience and satisfaction. The perception of an advantage is of importance, when considering its adaption.
Compatibility	Considers the degree of an innovation of being in line with adopters' needs, existing values and previous experiences. The more consistent with social norms and systems the more applicable an innovation is.
Complexity	Perceived difficulty to understand and use the innovation. The easier to understand, the faster it will be accepted and adopted.
Trialability	The length that an innovation can be experimented with before implementation. Pre-testing is considered as risk reducing and enables "learning-by-doing".
Observability	Concerns the visibility of results from the innovation. Clear and concrete results decrease the actors' uncertainty of implementation.

In conclusion, the analysis of the previous framework serves as a reference for the decision-making in a company regarding the adoption of Blockchain technology. However, an analysis of

each specific case must be conducted, delving into its possibilities and opportunities, but also in the possible uncertainty of the expected benefit. In particular, the logistics sector is characterized by being formed by a large number of parts and processes in which coordination and transformation are its two pillars. However, it will be necessary to establish general requirements, standards and governance models for Blockchain, based on multiple chains of reliable blocks.

2.3.6 Blockchain study in today's businesses

A study of various industry entrepreneurs was held to discuss how to face the relevance that Blockchain may have in their companies as well as the position they have before the adoption of the system (Hackius et al.,2018).

In addition, it was intended to analyze the level of knowledge that workers had on the operation and integration. The time period of the survey was between April 2017 and June 2017 and respondents were compiled by the BVL (German Logistics EV) through social networks, focusing on social interest groups. Most groups are from consulting, followed by logistics and finally scientists. Employees in manufacturing or retail companies supply chains were also surveyed (Petersen et al.,2017).

The results were different. The position taken by the company towards Blockchain, shows a percentage of 37% who could investigate the application of Blockchain in their processes and a 27% of them have decided to observe the development from a distance, followed by a 20% who could implement some blockchain solutions and finally a 16% don't want to introduce any technique.

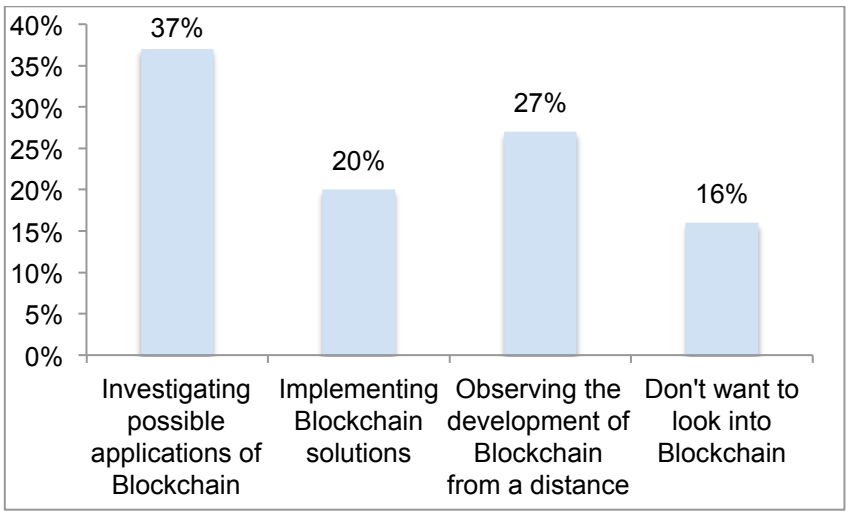

Figure 7. The position taken by companies toward Blockchain.
Source: Adapted from Mapping the Sea of Opportunities: Blockchain in Supply Chain and Logistics, 2018

Furthermore, respondents were also asked for the barriers to implementing this technology. A

percentage of 56% for the primordial problem was regulating uncertainty, a need to coordinate processes and the lack of technological maturity. Also, 49% felt that another cause was the lack of acceptance in the industry and 41% focused on concerns about privacy and security in data transfers. Lastly, 40% saw no clear long-term benefits and 28% did not want to rely on Blockchain operators.

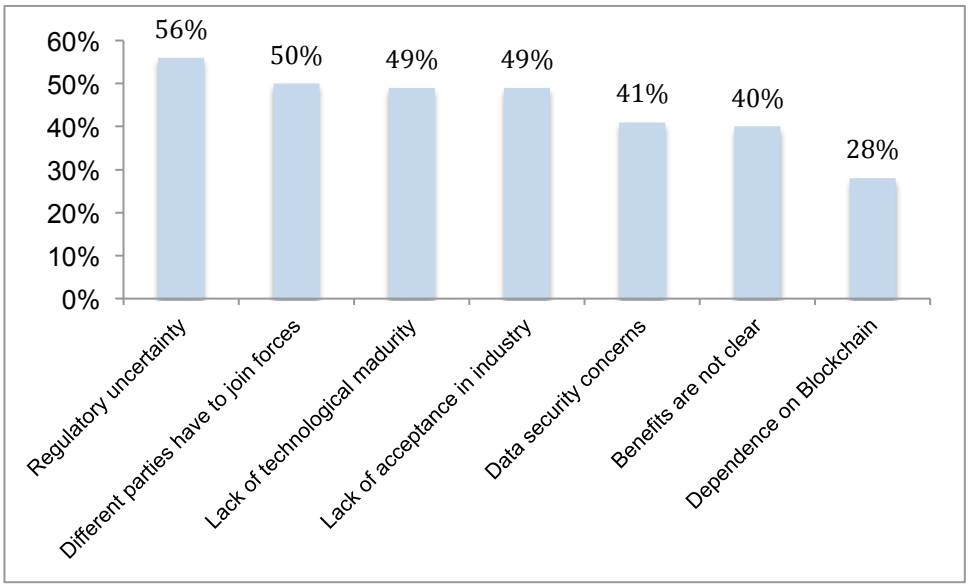

Figure 8. Barriers toward Blockchain. Source: Adapted from Mapping the Sea of Opportunities: Blockchain in Supply Chain and Logistics, 2018

Therefore, it is concluded that most companies are reluctant to investigate the issue and spend their own resources to implement this technology. This may be due to the current uncertainties and other factors such as those mentioned above (Sivula et al.,2018).

2.3.7 Current status in the logistics sector

Currently, the Blockchain technology is expected to help the logistics sector to update their procedures and activities efficiently. That is why they want to achieve consolidation and standardization in the coming years to ensure a successful implementation in companies.

Development initiatives that have been carried out so far revolve around various activities and are reaching a level of increasing interest (Liang, 2017).

First, international trade is one of the main sectors in which to apply this technology. Specifically, maritime trade could benefit by deploying this technology because of its high operational complexity and number of employees in different areas. In addition, thorough monitoring should be conducted where Blockchain could verify and expedite it, automating processes and reducing red tape.

Moreover, the inland freight transport is another area that could be benefited by this system by

creating platforms without intermediary contracting services, reducing transaction costs and facilitating communication between the parties (Glaser, 2017).

In addition, Blockchain allows time for the allocation and resources for the different actors in the system with accurate and immutable record. Therefore, traceability of products in the supply chain are being explored usefully, reaching to identify the product at any point in the process by verifying the quality and storage conditions. Thus, the current system would be transformed to a much more robust level of auditory and enhancing the authenticity and collaboration.

Finally, it could be improved the concept of " the last mile" which is a problem encountered by many companies. It is about the final shipment, in the time and expected conditions for the customer satisfaction. It is representative of one of the biggest challenges for the sector.

Currently, there has been an increased use of e-commerce, so the costs and inefficiencies in the shipment have been increased. To solve this problem, Blockchain would manage all consecutive actions, contacting customers and suppliers in real time and provide more options in picking orders, with the establishment of a common network of available collection points (Badzar et al.,2016).

In figure 9 we have a brief description about the part of order fulfillment where Blockchain can fit in.

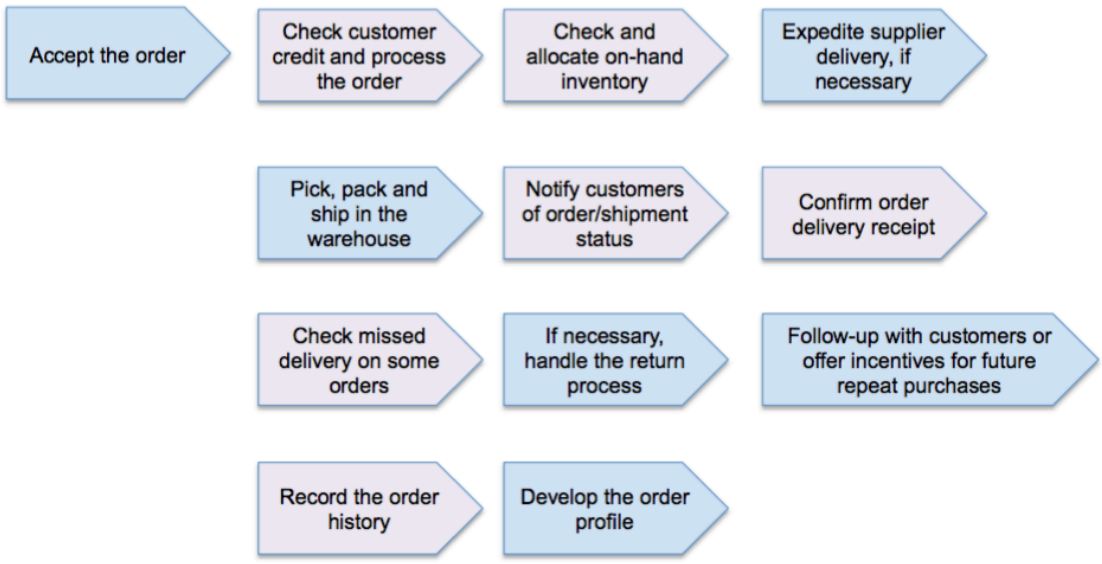

Figure 9. Part of order fulfillment steps where Blockchain can fit in. Source: Blockchain technology for enhancing supply chain resilience,2018

However, Blockchain can be used in other parts of logistics operations. Specifically, it will be expained the performance in supply chain in the next section.

2.3.8 Supply chain perfomance

Currently, the increased demand of goods has produced the need of digitization in the supply chain. Blockchain is an option for cloud integration which can provide benefits for businesses, not only in cost reduction but also for getting faster in processes and transactions (Dickson, 2016).

This technology involves all actors in the supply chain and ensures information security of the production process, tracking, delivery, etc. In addition, functions where both platforms Internet of Things and smart contacts are used, verify the starting conditions and legality control.

Due to the combination of blocks, information relating to past transactions can be displayed seamlessly and stored in a database which is published on the network.

The database is controlled by writing and reading, providing participants the ability to read and write in their own base. In order to maintain the confidentiality of the database, Blockchain requires a lot of security through encryption. Therefore, the main difference from a traditional database is the integration of the blocks and the intervention of the actors in them. Each participant can update the data autonomously without losing past data (Casey et al.,2017).

Blockchain is intended to be a way to gain transparency and accountability in the supply chain, increasing the visibility and optimization at each stage. It is also expected to reduce costs and create new business models with features that increase flexibility (Apte et al.,2016).

The usefulness of this system in the supply chain focuses on various parts, starting from production to delivery to the customer. Furthermore, it could also produce changes in the consumer behavior. Thus, the process would become more agile and fast, eliminating the need for procedures. It is expected that operations which are integrated in the system will be verifiable, trying to improve data management.

Currently, many of these fundamental questions about Blockchain not have been addressed yet. One consequence is that many companies do not implement such technology in their core business for a lack of confidence in obtaining benefits. Therefore, it must be address the problem of a lack of experience, organizational structure and scalability issues, providing companies with a management framework able to fully exploit the capabilities of blockchain.

To cope all the questions raised initially, articles and authors from different years were analyzed in order to obtain an overview of this topic. In addition, some exclusion criteria were used to refuse some papers as the reliability of the source or the language used in them. After selecting the most relevant articles it was passed to organize the work in sections, summarizing the main characteristics observed in each section. In this way it will be tried to achieve a strong and

effective study.

In order to implement the architecture of Blockchain in the supply chain it is necessary to establish common criteria to provide collectively. That is, the establishment of objectives based on business strategies is a key factor for getting the most leverage resources and benefits. These targets should be premised on the sharing data related to confidential transactions value.

Moreover, it is not only the creator of the product or service the responsable of providing blockchain quality architecture. There are many actors involved in the delivery process, such as suppliers, distributors or external agents who must do an effort to understand the complixity of the system. Thus, the company should be able to help chain partners to use these mechanisms efficiently and responsibly, creating parallel blocks in the network that are considered relevant.

However, it has to record that not all companies are suitable to adopt this technology. Small businesses which not working with high coordination among departments and data sharing is not a clear example of the type of company that Blockchain would head and the use of it could cause unnecessary additional cost. The typical profile could be a multinational company with its own manufacturing and distribution facilities and a wide network partners.

This type of company usually have a large supply chain, interacting with a huge number of employees and associates. From obtaining raw materials to the final stage, the product passes through places and different people and, therefore, it would generate a risk of information loss and vulnerability.

Therefore, it must perform an analysis of the main risk factors that can alter the course of the supply chain. This analysis consists of several steps. First, identify all members of the supply chain, showing the functions of each and interactions that occur between them. Later, once specified all members, a process map is done with the information flows and possible weaknesses, ie points where you may altercations occur (also including cyber attacks on information sharing). However, it should implement monitoring and control systems to verify if the plans reach the fundamental objectives (Dickson, 2016).

Moreover, Blockchain can become a tool to facilitate the above tasks, used to improve connectivity between the parties and reduce security breaches, providing computing resources and eliminating the handling in the process. Therefore it is important to identify what are the activities of the supply chain which could intervene to reduce risk and improving overall resilience. The basic mechanisms are focus on avoiding the risk, for example by displaying where is the bottleneck of the process and trying to get a solution.

In addition, Blockchain could give information about the system outages, providing information

about the lack of stock or the defects production. This way, the reserves production or a performance analysis of machinery fault stages could be studied (Badzar et al.,2016)
Blockchain technology could also provide a shorter response time to unexpected situations. It is a mechanism to transfer information in real time, so that an alteration in the chain would be easily visualized by workers (Ahram et al.,2017).

The transformation phases in logistics are presented in Table 6 and each of them yield benefits in supply chain performance as it can be observed.

Table 6. Transformation phases in Logistics. Source: Adapted from Blockchain for and in Logistics: What to Adopt and Where to Start, 2018

Single-use	• Enables monitoring, tracking and tracing in-house transports • Effective tracking of fleet and vehicle performance history • Gradual increase of blockchain start-ups, and active platforms
Localisation	• Easer paperwork processing • The extent of participation and information sharing is determined and regulated by the user • Facilitate origin tracking • Provide actors with the choice of buying sustainable products and transport • Customers gain the ability to evaluate the product or supplier before making a decision
Substitution	• Provide customers with the information they want concerning product origins and the freight route • Make load boards more reliable • Reduces risk in regard to fraud goods • Easier to execute transactions by using hashes instead of physical documents • Open access to information concerning the activities within the supply chain • Use IoT for vehicle to vehicle communication
Transformation	• Operate the internet of things • Simplifies exchange of goods and payment systems • Reduction of transaction costs • Exclusion of a centralized governmental institution • A network working on a platform in purpose of exchanging intangible resources • Multiple active platforms to just access both private and public

2.3.9 Challenges

Despite all the benefits described above, Blockchain also faces challenges still to be resolved as a result of its high complexity and its newness.

One of the most important challenges is the large capacity data that the system must have, being able to implement individual transactions to the general systems, updating that information in real time and sharing common data to a large number of computers. That is why today's technology should specify how to validate and enter information for each node without stoppages or saturations in the system (Casiona, 2018).

Furthermore, Blockchain is composed of several applications with different utilities and it is necessary to know the compatibility of these applications depending on the characteristics required.

On the other hand, the decentralization of the system allows users to deal with specific and personal data autonomously. That is why governmental organizations could exert some pressure to establish legislation that somehow controls the type of data that is handled and its legality (Zheng et al.,2016).

In the Table 7 is represented the prerequisites of blockchain versus traditional databases.

Table 7. Blockchain prerequisites. Source: A systematic literature review of blockchain-based applications: Current status, classification and open issues,2018

Attributes	Prerequisites and determinants	Permissionless	Permissioned	Database
Trust	• Lack of Trusted Third Parties	High	High	Low
	• Accountability	High	High	High
	• Immutability	High	High	Medium
	• Multiple non-trusting writers	High	High	Low
	• Peer-to-peer transactions	High	High	Low
Context	• Traceability of transactions	High	High	Low
	• Verifiability of transactions	High	High	Low
	• Data/transaction notarization	High	High	Low
	• Data transparency			L
	• Security	High	High	ow
	• Privacy	High	High	Low
		High	Medium	Low
Performance	• Latency and transaction speed	Low	Medium	High
	• Maintenance costs	High	High	Low
	• Redundancy	High	High	Medium
	• Scalability	Low	Medium	High
Consensus	• Rules of engagement	High	High	Low
	• Need for verifiers	High	High	Low
	• Autonomously	High	High	Low

CHAPTER 3 - SWOT ANALYSIS

In chapter 3, it has been made an analysis about the leading characteristics of Blockchain technology focusing on the architecture, platforms, challenges and the current status in logistics sector nowadays.

However, an analysis of the main strengths, threats, opportunities and weaknesses of Blockchain must be under carried to know what the pros and cons of this technology are, as well as the current state of development.

By analyzing the impact, having Blockchain in the future is not a simple task, since the technology is in an initiation phase and it does not yet exist a valid study of the its impact and the benefits that may result. However, with all the uncertainties that it entails, an analysis it is intended to be carried out based on recent studies reflecting an overview of the scope and implications of establishing a Blockchain model.

In order to fulfill this analysis, a study of its current situation must be carried out, specifying its main characteristics and observing the available resources and capacity to achieve a successful implementation in business. Moreover, additional possible usages of Blockchain are covered by highlighting potential but also limitations and risks. For this reason, articles by different authors and years of publication have been selected and studied.

In this chapter, it is intended that professionals will be able to extract the potential of this technology in their companies or, conversely, the inability to get benefits applying it in their processes. In addition, it is expected that not only professionals can understand this review but anyone who is interested in this topic.

In the beginning, an explanation about the origin of the SWOT method and its use over the years will be made. Moreover, a review of all the selected papers will be exposed, focusing on the approach and the application that each one is about. In addition, the methodology applied to carry it out will be also explained.

Finally, the final observations will be presented, summarizing the main common factors in the articles and also the main differences found among them.

3.1 Introduction

The SWOT analysis started being used in 1960 (Learned et al.,1995). In 1963, a business policy conference was held at Harvard, where the SWOT analysis was examined and discussed concluding that it represented a breakthrough in strategic planning (Panagiotou, 2003) .

After this time the SWOT analysis has become a key tool for the creation of business strategies (Ghazinoory,2011).

Alternatively, some methods such as resource-based planning (Wenerfelt, 1984) and competency-based planning (Ulrich et al.,1990) are used in many companies. Resource-based planning aims to analyze the internal resources, capabilities and competencies whcih are available, while competency-based planning uses the available skills to plan and design the strategies. However, these two approaches only analyze internal factors and they forget to take into account the external ones.

For this reason, the SWOT analysis has been chosen as the most convenient method in terms of studying Blockchain technology.

In addition, this analysis will be used to perform a questionnaire asking extracted aspects from the SWOT analysis. In the questionnaire, participants will be asked to rate the main influencing factors according to the importance that they consider, in a range of 0 to 5, being 5 the most important factor according to their perspective and 0 the least important factor, as well.

In this way, it will be possible to conclude if the professionals have an offensive or defensive position against blockchain and which are the most important factors for them. Moreover, it will also be possible to analyze if these companies are following the correct strategies taking into account the conclusions from the SWOT analysis.

3.2 Definition

SWOT analysis is a strategic planning tool to identify positive and negative factors that promote or inhibit the implementation of a technology in society. It is believed that it is a useful way to observe a technology potential. Moreover, this method could help organizations to take a decision about the introduction of Blockchain in their activities.

In addition, it is used as a tool that defines the strategy to be followed analyzing the strengths, weaknesses, opportunities and threats represented by the technology (Dyson, 2004). It is intended to analyze the environment in search of opportunities and threats and the internal situation in search of strengths and weaknesses (Ghazinoory,2011). In addition, it is also expected to compile and reduce the information drastically, focusing on the most relevant one (Helms, 2019).

In terms of using the SWOT analysis to assess the use of Blockchain in the logistics sector, it is important to define what are the considerations made in its use.

The negative characteristics which are making difficult the implementation of this technology and blocking the confidence of the companies are the weaknesses (internal) and the threats (external). Weaknesses are those internal factors that limit the possibilities of using Blockchain or project a disadvantage relative to other technologies. Threats are characterized as those external factors which can hinder the attainment of fundamental objectives of the use of the technology.

However, it must be also analyzed the positive properties, which are the strengths and the opportunities. The strengths involve a competitive advantage regarding other technologies. Alternatively, the opportunities are related to factors that could be achieved in the future and would provide Blockchain of other advantageous features.

At the end of this chapter it will be done a summary with the main ideas highlightling which are found in most of the case studies and trying to sum up the strengths, weakness, opportunities and threats.

3.3 Review of published SWOT papers

SWOT papers have been selected according to a variety of evaluation criteria. The first one based on collecting SWOT Blockchain analysis with generalist studies, in order to observe the differences or similarities between them. In addition, as the fundamental objective is the analysis of the current situation of Blockchain and the impact in logistics, most of the articles are published in the recent years with the purpose to have a realistic view of the Blockchain's current situation.

It was decided to focus the study on papers published in specialized journals since it is considered that this media collect relevant information and summarize the key concepts, facilitating the accomplishment of the SWOT analysis.

Moreover, the following keywords were used: Blockchain principles, Blockchain and supply chain, Blockchain strenghts, Blockchain oppportunities, Blockchain weakness, Blockchain threats and Blockchain SWOT. It was checked that these words appeared in the title, abstract or also in the keywords.

To conduct this literature review, databases have been searched and papers that have been published, up to the end of 2018, were recognized. These main databases were:
- Web of Knowledge

- Google Scholar
- Harvard Business review

In total, 10 articles have been selected and analyzed. However, the information inside them is linked to other previous published and referenced articles. Therefore, this analysis is based on a greater number of articles collected by reference, being more than 30 analyzed papers.

The years of publication of the 10 papers are between 2016 and 2018, with three articles published in 2016, three articles published in 2017 and four articles published in 2018.

3.3.1 Approaches in SWOT studies

The content of the documents could be divided into different sections.

The first one is composed by articles that aim to give an overview of this technology providing and focusing on its main strengths and weakness. The second one is composed by articles which have included a SWOT analysis with the aim to know if this SWOT analysis could be verified by the rest of the paper groups. Moreover as we want to measure the impact of Blockchain in logistics it have been selected some articles related to logistics and supply chain to check if the strenghts, weakness, opportunities and threats are similar with the general areas. In addition, it is vital to know if other technologies from the Industry 4.0 are presenting similar properties or, conversely, have significant differences with Blockchain. At the end, it was studied an specific article related to smart contracts as it is one of the most relevant applications in the field of logistics,

In this first section the following articles are included:

- Victoria Lemieux, 2017. "Blockchain record keping"
- Marten Risius, Kai Spohrer , 2017 "A Blockchain Research Framework"
- Marco Iansiti and Karim R.Lakhani, 2017, "The truth about Blockchain"
- Yli-Huumo J, Ko D, Choi S, Park S, Smolander K, 2016 , "Where Is Current Research on Blockchain Technology A Systematic Review"

In addition, articles in which a SWOT analysis is already made have also been searched to conclude if this analysis is a good approach for the establishment of the main strenghts, opportunities, weaknesses and threats also mentioned by the rest. In this way, a SWOT analysis published in 2018 and mentioned below was evaluated.

- M.Niranjanam urthy' B. N. Nithya, S. Jagannatha, 2018, "Analysis of Blockchain technology: pros, cons and SWOT"

Following the main object of this project, articles that relate this technology with the applications linked to supply chain and logistics have been evaluated. The main purpose was to observe if

the items not specialized in any specific area were the same as those related to logistics. That is, if the strengths, opportunities, weaknesses and threats also coincided with the mencioned in logistics as well. Thus, the following articles were analyzed:

- Tomaso Aste, Paolo Tasca and T Di Matteo, 2018, "Blockchain Technologies: foreseeable impact on industry and society"
- Kim, Henry M. and Laskowski, Marek (2016, "Towards an Ontology- Driven Blockchain Design for Supply Chain Provenance"
- Volodymyr Babich and Gilles Hilary, 2018, "Distributed Ledgers and Operations: What Operations Management Researchers Should Know about Blockchain Technology"

We also wanted to examine an article that links the blockchain technology with another one of the main tendencies of the industry 4.0, with the objective of observing what is the possible interaction between the two and what benefits would be obtained through the coordination and the implementation of both. For this, the following article was selected:

- Atzori, Marcella, 2016, "Blockchain- Based Architectures for the Internet of Things: A Survey"

Finally, an article linked to Smart Contracts was investigated, as this is one of the applications of Blockchain that would be used in the field of logistics. In particular, an article related to the insurance area was assesed as it was not possible to find an specific article related to logistics.

- Valentina Gatteschi ,Fa brizio Lamberti, Claudio Demartini, Chiara Pranteda and Víctor Santamaría, 2018 "Blockchain and Smart Contracts for Insurance: Is the Technology Mature Enough?"

For these reasons, the chosen documents are a mixture of methodological applications and case studies through which it has been tried to cover the Blockchain conception in most possible fields.

3.3.2 Application areas of SWOT papers

The Table 8 summarizes the selected articles with their main area of application:

Table 8. Areas and years in case studies

Paper title	Years	Area
Blockchain record keping	2017	Financial services, logistics
A Blockchain Research Framework	2017	Management and Organization
The truth about Blockchain	2017	Supply chain, telecommunication and computing sectors
Where Is Current Research on Blockchain Technology A Systematic Review	2016	Security, Bitcoin cryptocurrency
Analysis of Blockchain technology: pros, cons and SWOT	2018	Finance, services, goverment, health, logistics
Blockchain Technologies: foreseeable impact on industry and society	2018	Services, business and regulation
Towards an Ontology- Driven Blockchain Design for Supply Chain Provenance	2016	Supply chain
Distributed Ledgers and Operations: What Operations Management Researchers Should Know about Blockchain Technology	2018	Operation Management, data governance, supply chain management
Blockchain- Based Architectures for the Internet of Things: A Survey	2016	Transportation and logistics, healthcare, personal and social applications
Blockchain and Smart Contracts for Insurance: Is the Technology Mature Enough	2018	Insurance sector

3.4 SWOT analysis

3.4.1 Strenghts

In table 9 we can observe the main found strenghts in the following papers.

Table 9. Strenghts analysis by authors

Paper	Strengths
Victoria Lemieux, 2017. *"Blockchain record keeping"*	➢ **Alteration detection** ➢ **Increased efficiency** in information processing ➢ Records of **immutable transactions** ➢ **Fault tolerance** (The information is replicated in each node, if the system fails, the information is not lost)
Atzori, Marcella, 2016, *"Blockchain-Based Architectures for the Internet of Things: A Survey"*	➢ Platform to **connect multiple agents** with different information. ➢ **Improves communication** and **information sharing.** ➢ **Transparency:** Blockchain offers a mechanism of consensus where the transactions are validated by the participants. ➢ **Facilitate business-to-business interactions**
Yli-Huumo J, Ko D, Choi S, Park S, Smolander K, 2016 , *"Where Is Current Research on Blockchain Technology A Systematic Review"*	➢ Blockchain applications are not limited to cryptocurrencies. The technology could be **applied in different fields** where transactions are performed
Kim, Henry M. and Laskowski, Marek ,2016, *"Towards an Ontology-Driven Blockchain Design for Supply Chain Provenance"*	➢ Innovative solution in terms of **product tracking** ➢ **Blocks chained together** ➢ **Robust system** for the failure of individual nodes
Volodymyr Babich and Gilles Hilary, 2018, *"Distributed Ledgers and Operations: What Operations Management Researchers Should Know about Blockchain Technology"*	➢ Wide **variety of use cases** ➢ **Lower costs** of adding new participants ➢ **Visibility**: you can observe the elements along the entire chain ➢ The system **is robust to the failure** of single nodes
Valentina Gatteschi ,Fabrizio Lamberti, Claudio Demartini, hiara Pranteda and Víctor Santamaría, 2018 *"Blockchain and Smart Contracts for Insurance: Is the Technology Mature Enough?"*	➢ **Smart contracts** ➢ **Transparency:** everyone could read the transactions stored on it. ➢ **No need** for **intermediaries** ➢ **Automation** ➢ **Accessibility worldwide**

	➢ **Platform for data** analytics ➢ **No data loss/modification/falsification**
Marten Risius, Kai Spohrer , 2017 *"A Blockchain Research Framework"*	➢ **Smart contracts** enable autonomous mediation between transaction partners with- out the need for trust into the other party. ➢ There is **no control** of a **centralized server,** cost reduction ➢ Identification of inefficiencies in the chain ➢ **Truthfulness** ➢ **Accessibility**
Tomaso Aste, Paolo Tasca and T Di Matteo, 2018, *"Blockchain Technologies: foreseeable impact on industry and society"*	➢ **Community validation** ➢ **Blocks** are cryptographically **sealed and interlocked** one on top to other in a chronological sequence. ➢ **No** need of **human intervention. Automation** ➢ **Descentralised** and **transparent** consensus ➢ **Reliability** and reputation of clients and services providers can be verified and monitored by analyzing the historic record in the chain
Marco Iansiti and Karim R.Lakhani, 2017, *"The truth about Blockchain*"	➢ **Transactions** between two parties ➢ Records of the value and assets exchanged are **permanently entered** in all ledgers ➢ **No need for third-party-intermediaries** ➢ **Transparency** with pseudonymity (every transaction and its associated value are visible to anyone with access to the system) ➢ **Irreversibility of records** (the records can not been altered)
M.Niranjanamurthy' B. N. Nithya，S. Jagannatha, 2018, *"Analysis of Blockchain technology: pros, cons and SWOT"*	➢ **Descentralized** (doesn't have to rely on centralized node) ➢ **Transparent** (data's record is transparent to each node) ➢ **Autonomy** (base of consensus) ➢ **Immutable** (any record will be reserved forever) ➢ **Automation**

3.4.2 Weaknesses

In table 10 we can observe the main weakness found in the collection of papers under analysis.

Table 10. Weaknesses analysis by authors

Paper	Weaknesses
Victoria Lemieux, 2017. *"Blockchain record keeping"*	➢ **Preservation of** long-term **information** ➢ **Insufficient control** (an organization can eliminate transactions if it has control of the chain of blocks and relevant information would be lost) ➢ **Possible incoordination** (absence of a centralized server)
Atzori, Marcella, 2016, *"Blockchain-Based Architectures for the Internet of Things: A Survey"*	➢ For large block chains **large computing and power capabilities** are required ➢ It is not about acquiring data or operating with them, Blockchain **is only used to store** the information,
Yli-Huumo J, Ko D, Choi S, Park S, Smolander K, 2016 , *"Where Is Current Research on Blockchain Technology A Systematic Review".*	➢ **Latency** is a big problem. It is intended to make a block and confirm the transaction in seconds. ➢ Blockchain needs to **control** more transactions, **problems of size** and **bandwidth.**
Kim, Henry M. and Laskowski, Marek (2016, *"Towards an Ontology-Driven Blockchain Design for Supply Chain Provenance".* CoRRabs/1610.02922	➢ **Immaturity** ➢ **Inability to modify** transactions once validated
Volodymyr Babich and Gilles Hilary, 2018, *"Distributed Ledgers and Operations: What Operations Management Researchers Should Know about Blockchain Technology"*	➢ **Inefficiency**. Large amount of electricity to make the calculations and a broad bandwidth to transmit and updated records to all the nodes which are integrated in the system ➢ **Absence of** a mechanism that relates **the records of the chain to business activity** ➢ Typically **more inefficient** than the **traditional data** base technology

Valentina Gatteschi ,Fabrizio Lamberti, Claudio Demartini, Chiara Pranteda and Víctor Santamaría, 2018 *"Blockchain and Smart Contracts for Insurance: Is the Technology Mature Enough?"*	➢ It has been estimated that a business should wait between **3 and 5 years to notice if Blockchain is providing benefits** when deciding to invest or not in blockchain ➢ **Scalability** ➢ **Low performance** ➢ **Energy consumption** ➢ Reduced users **privacy** ➢ **Need to rely** to external oracles ➢ **No intermediary to contact** in case of loss of users' credentials ➢ **Volatility** of cryptocurrencies ➢ Still in an **early stage** (no "winning" blockchain, need of programming skills to read code, blockchain concepts difficult to be mastered) ➢ **Same results** achieved with **well-mastered technologies** ➢ **Not suitable** for all existing processes
Marten Risius, Kai Spohrer , 2017 *"A Blockchain Research Framework"*	➢ In theory, public channels are decentralized, but normally it is an **organization or company** that **controls** them. ➢ **Lack of standardization**. It does not have a unique protocol.
Tomaso Aste, Paolo Tasca and T Di Matteo, 2018, *"Blockchain Technologies: foreseeable impact on industry and society"*	➢ Very large amount of electricity ➢ **Speed limits** ➢ Governance in distributed systems is a very complex matter where **minorities can autonomously separate** from the system while keeping technology and assets but trading on parallel forks ➢ Tendency towars **concentration** and creation of semimonopoliste regimes
Marco Iansiti and Karim R.Lakhani, 2017, *"The truth about Blockchain*"	➢ It will take **decades** for blockchain **to seep** in our economic and social infrastructure
M.Niranjanamurthy' B. N. Nithya，S. Jagannatha, 2018, *"Analysis of Blockchain technology: pros, cons and SWOT"*	➢ **Acces challenge** ➢ **Technology madurity** ➢ **Scalability** ➢ **Low capacity** and processing speed ➢ **Storage** ➢ **Security** against cyber criminals ➢ A lot of **research** needs to be done ➢ **High investments**

3.4.3 Opportunities

In table 11 we can observe the main opportunities collected from the papers.

Table 11. Opportunities analysis by authors

Paper	Opportunities
Victoria Lemieux, 2017. *"Blockchain record keeping"*	➢ **Innovation** and **cost reduction**, with the implementation of smart contracts, for example.
Atzori, Marcella, 2016, *"Blockchain-Based Architectures for the Internet of Things: A Survey"*	➢ If the normal process is altered for an unforeseen or failure, Blockchain not only notifies the direct supplier, but also **all the agents** involved in the supply chain, informing about the possible interruption of the system
Yli-Huumo J, Ko D, Choi S, Park S, Smolander K, 2016 , *"Where Is Current Research on Blockchain Technology A Systematic Review".* PLoS ONE 11(10), pp.1-27	➢ Better **protection of privacy with the validation system** ➢ **Higher individual control** over personal data.
Kim, Henry M. and Laskowski, Marek (2016, *"Towards an Ontology-Driven Blockchain Design for Supply Chain Provenance".* CoRRabs/1610.02922	➢ **Possibility of tracking** from one entity to another
Volodymyr Babich and Gilles Hilary, 2018, *"Distributed Ledgers and Operations: What Operations Management Researchers Should Know about Blockchain Technology"*	➢ **Faster transaction system** ➢ According to Google Trends, **popular interest** skyrocketed towards this technology in 2017 ➢ **Improve the coordination, visibility and validation** of orders by providing accurate information on sales and used resources
Valentina Gatteschi ,Fabrizio Lamberti, Claudio Demartini, Chiara Pranteda and Víctor Santamaría, 2018 *"Blockchain and Smart Contracts for Insurance: Is the Technology Mature Enough?"*	➢ **Increase** the **speed of the claim**. processing, as well as to reduce the costs (and errors) associated with the manual process of claims ➢ **Reduce/hide the complexity** behind blockchain are successful, or in case of diffusion of IoT) ➢ **Possibility to address new markets** (e.g., supporting car and house sharing, disk storage rental, etc.) ➢ **Availability** of a huge amount of heterogeneous data, pushed in the blockchain by different actors

Marten Risius, Kai Spohrer , 2017 *"A Blockchain Research Framework"*	➢ **Identify** the **bottlenecks** of the process
Tomaso Aste, Paolo Tasca and T Di Matteo, 2018, *"Blockchain Technologies: foreseeable impact on industry and society"*	➢ Creation of platforms for exchange of information, assets and digitized goods **without the need of intermediaries** ➢ **Enhace** the enforcement of **regulatory controls** ➢ **Use with other technologies** (artificial intelligence, cloud computing…) **can disrupt many business** sectors.
Marco Iansiti and Karim R.Lakhani, 2017, *"The truth about Blockchain*"	➢ Individuals, organizations, machines and algorithms **would freely transact and interact** with one to another ➢ Blockchain could dramatically **reduce the cost** of transactions ➢ To use block- chain technology **internally as a database** for applications like managing physical and digital assets, recording inter- nal transactions, and verifying identities. ➢ **To track items** through complex supply chains
M.Niranjanamurthy，B. N. Nithya，S. Jagannatha, 2018, *"Analysis of Blockchain technology: pros, cons and SWOT"*	➢ Business process **optimitation** ➢ **Elimination of trust necessity** ➢ **Faster payments** ➢ Improved **customer experience** ➢ Increased **quality of products** ➢ **Opportunities** in IoT

3.4.4 Threats

In table 12 we can observe the main threats selected from the papers under analysis.

Table 12. Threats analysis by authors

Papers	Threats
Victoria Lemieux, 2017. *"Blockchain record keeping"*	➢ **Excessive control** by an organization or company
Atzori, Marcella, 2016, *"Blockchain-Based Architectures for the Internet of Things: A Survey"*	➢ **Privacy and confidentiality** could be lost or **manipulated** when the nodes are connected ➢ In public block chains, **anyone can access the information**
Yli-Huumo J, Ko D, Choi S, Park S, Smolander K, 2016 , *"Where Is Current Research on Blockchain Technology A Systematic Review".* PLoS ONE 11(10), pp.1-27	➢ Blockchain is **vulnerable to** many types of **attacks,** specifically, if a node has 51% possession of the blockchain, it can dominate all the others by manipulating the records
Kim, Henry M. and Laskowski, Marek (2016, *"Towards an Ontology-Driven Blockchain Design for Supply Chain Provenance".* CoRRabs/1610.02922	➢ Automation based on the execution of transactions with certain **pre-established conditions.** If a change occurs in any initial condition the transactions will be performed with the initial conditions
Volodymyr Babich and Gilles Hilary, 2018, *"Distributed Ledgers and Operations: What Operations Management Researchers Should Know about Blockchain Technology"*	➢ **False records** Difficult to eliminate. ➢ **Excess of information** collected. It could be difficult to separate useful information from the one that does not ➢ **Possible fakes** in the product specifications ➢ **Failure in the system** of algorithms responsible for automatic optimization ➢ **Possible fraud** in the provision of data by suppliers.
Valentina Gatteschi ,Fabrizio Lamberti, Claudio Demartini, Chiara Pranteda and Víctor Santamaría, 2018 *"Blockchain and Smart Contracts for Insurance: Is the Technology Mature Enough?"*	➢ Could be perceived as **unsecure/unreliable** ➢ Low adoption from external actors means **lack of information** ➢ Governments could consider blockchain and smart contracts **"dangerous"** ➢ Medium-long term **investment** ➢ Customers would still consider **personal interaction important** ➢ **Suppliers could not want to participate** in the system for having to share information ➢

Marten Risius, Kai Spohrer , 2017 *"A Blockchain Research Framework"*	➢ Data analytics can be used to gain insights into activities of single users as well as entire blockchain systems. While this can be seen as a strength regarding auditability, it can also be viewed **as a threat from a privacy** perspective
Tomaso Aste, Paolo Tasca and T Di Matteo, 2018, *"Blockchain Technologies: foreseeable impact on industry and society"*	➢ Participants do not even need to be humans, they can be **autonomous agents.** ➢ **Excessive concentration**
Marco Iansiti and Karim R.Lakhani, 2017, *"The truth about Blockchain*"	➢ With the use of private networks, **companies must trust** that the responsible operation and validation agencies of the chain will be able to verify the integrity and availability of the records. Therefore, it is probable that traditional contracts have to be determined in order to establish the bases and guarantees.
M.Niranjanamurthy' B. N. Nithya，S. Jagannatha, 2018, *"Analysis of Blockchain technology: pros, cons and SWOT"*	➢ **Huge regulatory impact** ➢ **Privacy** and **security uncertainty** about the impact

3.4.5 Conclusion

After collecting the different SWOT points from different authors, it can be concluded that there are clear characteristics of Blockchain which appear all of them papers analysed**.**

On the one hand the main **strengths** are the **descentalization, transparency, immutability and verification.** These properties form the technology basis.

Particularly, one of the main new advantages is the **absence of a centralized organization** to control the structure and process, providing a consensus mechanism to ensure the nodes transactions, which is called the "descentralization" aforementioned. There are many authors who emphatise with this property like Risius and Spohrer (2017), Di Matteo et al. (2018), Iansiti and R.Lakhani (2017) and M.Niranjanamurthy et al. (2018).

Moreover, another important feature is the **quality of the data,** being complete, consistent, and widely available. In addition, the technology aims to eliminate the discrepancies caused by the veracity of the data. In this case Victoria Lemieux (2017) supports that the benefit is that the information is replicated in each node and if the system fails, the information is not lost. Kimet al. (2016) and Babich and Hilary (2018) also maintain that Blockchain has a robust system when occuring the failure of individual nodes. In addition Iansiti and R.Lakhani (2017) ensure that records of the value and assets exchanged are permanently entered in all ledgers.

It is assumed that Blockchain **is harder to withstand malicious attacks** as all the information is available in each node and the participants must verify the transactions. Therefore, if a failure appears in a node, the information is not lost. However, it is true that some authors alert the problem of an **excessive control** by an organization or business as Victoria Lemieux (2017) or Di Matteo et al. (2018) who claims the excessive concentration. This fact could cause false records and a perception of an unreliable system to the rest of the members.

In addition, Blockchain could also contribute to **improve the economy** of a business. First of all, **improving the transactions** speed and diminishing **the operational cost** as Atzori, Marcella (2016), Babich and Hilary (2018) and Iansiti and R.Lakhani (2017) assure. Furthermore, it is possible to **automate** process and operations by giving some compliance conditions as Gatteschi et al. (2018), Risius (2017) and M. Niranjanamurthy et al. (2018) mencione in their articles.

It was found other strengths as the **capacity** of using Blockchain in many **different sectors** as Yli-Huumo J et al. (2016) and Babich and Hilary (2018) take in account or the innovate solution in terms of product tracking by Kim et al. (2016).

On the other hand, the **opportunities** are related to factors that are not well established at this moment and could be achieved over a medium or long term.

The first one is the purpose of creating a system where all the members can observe and verify the complete process. This fact implies that the agents involved should introduce **information in real time** about the product. Babich and Hilary (2018) ensures that Blockchain could transform the industry into a faster transaction system. In addition, Iansiti and R.Lakhani (2018) assert that Individuals, organizations, machines and algorithms **would freely transact and interact** with one to another In this way, the customers will be able to know where is the product and when it will be available, **improving their satisfaction** as M.Niranjanamurthy et al. (2018) make certain. Moreover, the system would become **simpler** and **easier** to coordinate.

Nevertheless, Blockchain not only could be used for sharing information with other companies or agents but also it could be a **great internal data-base** for a business, not having to share reliable information with other agents and decreasing the problem of excessive information. This opportunity is described in Yli-Huumo J et al. (2017).

Gatteschi et al. (2018) claim the possibility **to store** a huge amount of **data,** providing the past transactions and recording past actions into a blocks. They also say that the members would have an individual control of the information.

Moreover, other opportunities which have been found were the **Innovation** and **cost reduction**, with the implementation of smart contracts by Victoria Lemieux (2017), the **Improvement with the coordination, visibility and validation** of orders by providing accurate information on sales and used resources by Babich and Hilary (2018) and the **use with other key technologies by** Di Matteo (2018) and M.Niranjanamurthy (2018).

As this technology is not completely established, it **is difficult to separate strengths and opportunities.** For example, the validation system improves the transaction security, nevertheless, currently it is still somewhat confusing and non-well established. Therefore, it could be considered as a threat too.

However, Blockchain also presents some **weakness and threats** that obstruct the implementation in business.

First of all, one important weakness is the **technology maturity** as Kim et al. (2016), Iansiti and R.Lakhani (2017) and M.Niranjanamurthy (2018) set forth**.** Blockchain has not achieved a great level of maturity capable of giving confidence to companies and individuals. Moreover, the possible benefits of this technology can not be verified until a few years.

Victoria Lemieux (2017) speaks about the **insufficient control** and **preservation of long-term information** which are other presented issues in this case of study. Therefore, **privacy and security** could be damaged with networks where everyone can be introduced to manage the data as Gatteschi (2018) present in their study and also M.Niranjanamurthy (2018).

Moreover, as this system is decentralized, there is **not an intermediary** to contact in case of loss users or system shutdown. This fact could also cause **incoordination and a lack of latency,** recording different information and introducing false physical state of an asset according to Gatteschi (2018) and Victoria Lemieux (2017).

The **scalability** and the need to consume huge amounts of **electricity** represent a challenge for Blockchain as it requires using wide bandwidths to do the transactions in real time, connecting all the participants and updating the data continually. It has been observed that many articles warn of this problem as Yli-Huumo J et al. (2016) who say that Blockchain could have **problems of size** and **bandwidth,** Babich and Hilary (2018), Gatteschi ,et al. (2018) and Di Matteo et al. (2018). Therefore, Blockchain was created to be used in big companies where a lot of data is managed.

Furthermore, it does not have a unique protocol to standardize the system and this **lack of standardization** generates controversies and uncertainty according to Risius and Spohrer (2017).

Another weakness is the **inability to modify** transactions once validated (Kim et al. 2016), **the absence of** a mechanism that relates **the records of the chain to business activity (**Volodymyr Babich and Gilles Hilary, 2018) or even the achievement of get the **same results** with **well-mastered technologies** (Gatteschi et al. 2018).

Finally, there are some current **threats** as **excessive control and concentration** by an organization controlling most of the nodes and the **excess of no useful information** which could do difficult to find the useful one (Victoria Lemieux, 2017).

False records are difficult to eliminate and some members could not want to introduce in the system confident information (Gatteschi et al. 2018). In addition, **customers** have to trust in this system without any human interaction and exposing yourself to possible failure in the algorithms system (Risius and Spohrer, 2017). In addition, **Suppliers could not want to participate** in the system for having to share information (Gatteschi et al. 2018).

Possible fakes, the possibility of **failure** in the system and the **vulnerability** to many types of attacks are other threats mencioned by Babich and Hilary, 2018.

In the logistics sector Blockchain could be applied for many applications. The strengths above mentioned could also contribute to generate great changes in the business models and processes but also the weakness have to be considered.

CHAPTER 4 - INTERVIEW

4.1 Introduction

A qualitative method has been selected to verify the results of the SWOT analysis: an interview. The interview is a technique of data selection where the participants can express their own opinion about one topic. Therefore sometimes it is difficult to separate relevant information if you are not able to ask with the correct words.

Nevertheless it is a interesting method to obtain some insights into the attitude, knowledge and participants position about Blockchain. Moreover with this method it is possible to study subjetive viewpoints in different social groups. The aim may be to generate hypothoteses for later studies but also the interpretation of other past studies as, in this case, SWOT analysis (Uwe Flick, 2009).

Another advantage of this method is the economical and timely data collection. Usually the interview is a quick way to obtain specific data. However, It is true that in this case it has not been an easy task to receive the interview as business have to take time doing it and sometimes it is complicated for them.

The participants have been selected according to some criterias such as business area , Blockchain knowledge and relation with logistics.

In this section the participants have to interact with the interviewer in different ways. They not only have to answer questions, but also classify the main factors extracted from the SWOT analysis. Moreover, they have the opportunity to answer openly making specific considerations.

It has been used some criteria during the design of the interview. The first one is non-direction, making questions in different forms, general question at the beginning and more specific ones after that. In addition, specificity is another main purpose, bringing out the specific elements to determine the impact of logistics in order to prevent the interview from remaining on the level of general statements. These criteria suggest for conducting the interview incorporate some targets which cannot be matched in every situation (Uwe Flick, 2009).

The interview allows to make an specific analysis of Blockchain and its impact in logistics as it has been made to observed the opinion of different companies according to their own experience.

4.2 Definition

During the last years qualitative research has come to refer to selected methods used in explanatory designs. Moreover, one of the main purposes is to gain preliminary insights into

decisions problems and opportunities. Thus, qualitative research try to focus on collection detailed amounts of data from small sample observing the participants behavior and getting conclusions about one topic. (F.Hair et al. 2002)

The first focused interview was developed in 1940 by Robert Merton who was one of the most influential sociologists in the United States. The original aim of the interview was to provide a basis for interpreting significant findings (Uwe Flick ,2009).

The concept of qualitative method analyzes the whole discourse between the subjects and the relation of meaning for them, accordint to cultural, ideological and sociological contexts. In toher words, it investigates why and how a decision was made. It could be extended at this work, knowing why a company has implemented Blockchain or why not, for example.

Moreover, qualitative research is primarly exploratory research and it is used to uncover trends and dive deeper a problem.

4.3 Structure

The estrcuture of the interview is divided into the following parts:

First of all, in the Part A, it will be proposed several questions with the purpose of knowing what is the main activity of the company and the occupied position by the interviewee. The objetive of these questions is to study whether depending on the scope of the company or the interviewee position the knowledge or opinion about Blockchain is different.

In addition, during the first questions it is intended to find out if the interviewee has a specific and rigorous understanding about this technology or he has only heard general information about Blockchain. If the interviewee in an expert in relation with this technology and the company is already using Blockchain it will be possible to obtain a lot of valuable information about the real strenghts and weakness of this technology and the current use in a business.

However, if the interviewee is a person who only has general Blockchain notions we can interpret what is the position on Blockchain and what is also the opinion about it. In summary the questions 1.1 to 1.13 are general questions for being applied to everyone who have participated.

Despite this, the questions 1.14 to 1.27 have been proposed to be answered by companies that have implemented the technology in their processes or activities. The first questions aim to be conscious of the time that the company is using Blockchain and the main reason why they implemented it in the past. It will then be asked for the differences between a traditional database and Blockchain as several authors in the SWOT analysis insure that there are no

relevant differences. Moreover, it is wanted to know how Blockchain works in terms of legality, finances and the use of smart contracts, therefore the interview is also focusing on that.

However, one of the most important value of the interview is to know about the benefits and the use of Blockchain with other technologies making an integration and working together. Some questions have the protection and cybersecurity as the main topic as these aspects are one of the most controversial in the SWOT analysis. Finally it is inquired if the interviewee believes that Blockchain could change the way of carrying put activities and processes in logistics.
In Part B it is intended to study the critical factors extracted from the SWOT analysis which are descentralization, transparency, immutability, quality of the data, automation, cost reduction, visibility, validation, privacy, security and vulnerability. The interviewee has to select the choice which reflects his opinion about the most important Blockchain's factors that could impact in the business and in logistics,as well, being one the less important ,five the most important factor and NA (not aplicable). This part pretends to identify the most relevant factors in the scope of the company and also in logistics.

In Part C a SWOT analysis classification is made. The interviewee has to classify the critical factors into strengths, weakness, opportunities and threats, being able to mark two at the same time if he considers as correct.

Finally in the last Part ("Part D"), a section has been created for own considerations or aspects about Blockchain.

Appendix 1. Interview

Interview

Blockchain in logistics

Belén Martínez Laosa

Dear Participant,

The following interview is a study as a part of a dissertation in the field of the Master in Industrial Engineering and Management at Instituto Superior Técnico, University of Lisbon, Portugal. The purpose of this study is to identify the most important factors involving to Blockchain's technology and the impact in logistics.

I would like to invite you to participate in this interview and I assure you that all the information provided will be used solely for the purpose of the work. All this information will be treated in the strictest confidence and your identity will be anonymous.

I would like to express my thanks in advance for your kind cooperation and ask you to spend a few minutes doing the interview.

If you have questions about this study, contact me through the email bemarlao95@gmail.com

Yours faithfully,

Belén Martínez

PART A - QUESTIONS

- **General** questions:

1.1 What is the company sector?

1.2 What are the main activities in the company?

1.3 What are the main challenges to solve in the company according to the main activity? (for example in the case of a logistic company could be the effective communication between the actors)

1.4 Do you know what Blockchain is? Please provide your brief understanding about it.

1.5 Do you know what are the benefits of Blockchain?

1.6 Do you know what are the drawbacks of Blockchain?

1.7 Do you think that this technology is more reliable than a traditional one (a centralized technology)? Why?

1.8 Would you use the blockchain technology internally as a database for applications like managing physical and digital assets, recording internal transactions, and verifying identities? Why?

1.9 What are the main reasons why you would invest in this technology? Why?

1.10 How could you implement Blockchain in your business?

1.11 Do you think that Blockchain could improve confidence in relations between actors?

1.12 Do you think it could be a solution for logistic operations? Which ones?

1.13 What do you think about the future of Blockchain?

- If your company has already implemented **Blockchain**, please answer to questions 1.15 to 1.29:

1.14 Why did your company start using Blockchain?

1.15 How was the implementation of Blockchain?

1.16 How was the decision to acquire this system? What kind of studies did you do to undertake this decision?

1.17 For how long are you using Blockchain?

1.18 How is the blockchain database different from traditional databases?

1.19 How does blockchain work both financially and legally?

1.20 Are the operators and consumers more or less protected in this technology?

1.21 Is Blockchain more or less stable during periods of stress?

1.22 How much collective irrational phenomena such as sentiment/confidence swings will affect the capability to operate?

1.23 Do you use smarts contracts? How is the development of smart Contracts related to Blockchain technology?

1.24 How can you govern and regulate this system to avoid abuses and protect users?

1.25 What is the use of Blockchain for digital protection and cibersecurity?

1.26 What are the benefits achieved with Blockchain?

1.27 Do you use Blockchain with other technologies (Internet of things...)?

1.28 Do you think that it could change the way of carrying put activities and processes in logistics?

PART B - BLOCKCHAIN CRITICAL FACTORS

Please select the choice which reflects your opinion about the most important Blockchain's factors **that could impact in your business**, being one the less important ,five the most important factor and NA (not aplicable). (Mark only one square per row)

➢ Descentralization	1	2	3	4	5	NA
➢ Transparency	1	2	3	4	5	NA
➢ Immutability	1	2	3	4	5	NA
➢ Quality of the data	1	2	3	4	5	NA
➢ Automation	1	2	3	4	5	NA
➢ Cost reduction	1	2	3	4	5	NA
➢ Visibility	1	2	3	4	5	NA
➢ Validation	1	2	3	4	5	NA
➢ Privacy	1	2	3	4	5	NA
➢ Security	1	2	3	4	5	NA
➢ Vulnerability	1	2	3	4	5	NA

Please now select the choice which reflects your opinion about the most important Blockchain's factors **that could impact in logistics**, being one the less important ,five the most important factor and NA (not aplicable). (Mark only one square per row)

➢ Descentralization	1	2	3	4	5	NA
➢ Transparency	1	2	3	4	5	NA
➢ Immutability	1	2	3	4	5	NA
➢ Quality of the data	1	2	3	4	5	NA
➢ Automation	1	2	3	4	5	NA
➢ Cost reduction	1	2	3	4	5	NA
➢ Visibility	1	2	3	4	5	NA
➢ Validation	1	2	3	4	5	NA
➢ Privacy	1	2	3	4	5	NA
➢ Security	1	2	3	4	5	NA
➢ Vulnerability	1	2	3	4	5	NA

PART C - SWOT ANALYSIS CLASSIFICATION

Please classify the critical factors as Strength, Opportunity, Weakness or Threat according to Blockchain technology. It is possible to mark one per row or you can also mark more than one justifying the reason below (*).

Factors	Strength	Opportunity	Weakness	Threat
Descentralization				
Transparency				
Immutability				
Quality of the data				
Automation				
Cost reduction				
Visibility				
Validation				
Privacy				
Security				
Vulnerability				

* Please write here the justification

PART D - CONSIDERATIONS

Please add other considerations that you may find important to measure the impact of Blockchain in your business.

4.4 Selection of participants

The first business is a company that makes digital marketing campaigns creating a lasting relationship between influencers and the brands. The main activities are related to digital marketing and this company has not used Blockchain in the current activities and processes. However, they have a great knowledge of Blockchain's utility and applications.

The second company is a new Startup. The system was developd for fighting conterfeit and brand protection. They have a lab that produces random numbers using quantum mechanics for ensuring unicity and irreprodutibility of numbers. Manufacturers can have these numbers in the associated distribution chain to track their products. Each step of the supply chain is written on the Blockchain platform for ensure product originality until be delivered to the final consumer.

The final consumer can download App to read QR Code (or some IoT/RFID/NFC) printed on the label of this product. This App show information if this product is real or fake. The proposal is to produce random numbers based on quantum criptography and sell these numbers associated with the system and the application. The main activity is producing the numbers, write steps on Blockchain and manage the Big Data for generating information that can be used by the marketing team.

Finally, the third company takes care of guaranteing efficient and competitive transport, logistics, and auxiliary services solutions, promoting the satisfaction of customers from the economic, social and environmental. Moreover, they have an innovate concept of integration and verticalization of logistics services on Iberian scale, based on the network of logistics operations centers and regional platforms, which guarantees a daily Iberian distribution with high levels of service and quality standards, and reduce lead times.

The choice of these three different companies has specific purposes. First of all, we want to know what they think about Blockchain depending on the area and application. Moreover, it is very useful to have the overview of this technology in a business where is not already implemented and, conversely, in one business where Blockchain is already being used.

We have approached other companies acting the field of logistics and also on the field of cybersecurity, but under the timeline of completion of this thesis, we were not able to collect answers from key persons on those businesses.

4.5 Results

First of all, in the Part A the companies agree with the idea that the main benefits of Blockchain are immutability, reliability, longevity, integrity and transparency. However, the main drawbacks are related to recognition of the law and unestable regulatory state. Therefore, everyone would engage this technology if these problems are solved and surpassed.

In addition, all the participants are in agreement that Blockchain is more reliable than a traditional database as it is a descentralized system, which makes difficult to falsify information. They hope that international rules, policy and procedures for authenticating papers and transactions will be established in the future.

Moreover, they agree with the idea that it could be used in logistics focusing on the application of authentification but also the ability to track the product from the initial to the final stages.

In part B they have to select the most important Blockchain factors depending on the impact in their business and what they think about logistics.

On the one hand, referring to the impact on the company in general, descentralization, transparency, immutability and validation are the most voted by the companies. Security is also voted as one of the significant factors but not with a five rating but also a four. Privacy, quality of the data and automation are the factors with a lower score, from 1 to 2 depending on the company. Moreover, cost reduction and visibility are not applicable according to the business.

On the other hand, they don't think that these factors are equal to logistics, therefore the results are not the same and the score is different in some factors. First of all, they consider that decentralization, transparency, immutability and security are the main factors to this area, providing them a five score. Automation, visibility and and validation are the following ones with a three score. In this case, privacy has a 2 score and cost reduction and quality of the date only a one. Vulnerability is not applicable in the logistics area according to the participants.

In part C, they have to classify the factors as strengths, opportunities, weakness or threats.

Table 13 summarizes the results obtained where participants had to mark with one "x" their own factor clasification.

Table 13. Results from the Interview – Part C

Factors	Strength	Opportunity	Weakness	Threat
Descentralization	xxx			
Transparency	x	xx		
Immutability	xxx			
Quality of the data		x	x	x
Automation			xxx	
Cost reduction		xxx		
Visibility		xxx		
Validation	xx	x		
Privacy		x	x	x
Security	xxx			
Vulnerability		x		xx

As it can observed they agree that descentralization, immutability and security are strengths of this technology. Transparency and validation are between strengths and opportunities. Visibility and cost reduction are considered as opportunities by the companies. However, they think that automation is the main weakness. The same thing not happen with the rest of the factors. There are discrepancies in what participants suppose. Quality of the data and privacy are considered as an opportunity, but also a weakness and threat. Finally, vulnerability is understood as a opportunity but also a threat.

Therefore, it can be affirmed that strenghts and opportunities are clear for the participants but in the negative factors they have different meanings.

4.6 Limitations

The discussion about the final results should be complemented by limitations' analysis.
It is understood that limitations are the factors which make the research restricted. In addition, they could influence the final results and conclusions. Clarifying these limitations one can be able to understand the focus and the reliability of the work.

One of the main limitations of this study is the sample size, being too small (composed by three companies). Therefore, a larger sample would result in more rigorous and truthful results, reducing the error margin.

There are two reasons why it has happened. The first one is related to the companies and the second one is related with the technology. On the one hand, it is very difficult to find a company who wants to participate in this kind of activities as they do it voluntarily and not getting any direct profit or direct benefit from it. On the other hand, as Blockchain is an emerging technology, it is complicated to meet someone who really has a deep knowledge about it.

Therefore, we are aware of the need for this study to continue for being complemented and also updated with more candidates over the time.

CHAPTER 5 - CONCLUSION

After the study carried out throughout the work it can be made some conclusions about the impact of Blockchain in logistics.

First of all, the aim of this study was to understand this technology and identify the use and possible applications of Blockchain in logistics.

On the ond hand, the decentralization of the technology generates trust in the network participants. As it has been observed in the interview, one of the strongest points of this technology is the absence of a central controlling entity which provide customers security and reability. In addition, much faster transactions could be carried out with a higher level of security. These transactions would be immutable over time and would have an indeformable record of them. In addition, the use of smart contracts would be a necessary tool in companies related to logistics changing the way of doing processes and activities. The possibilities of this technology extend to many areas and factors and would affect business models.

Therefore, it is concluded that the impact that Blockchain could have in the long term in the logistics sector is very high, managing to transform the sector and helping to improve times and operations and increase the transparency of the supply chain. Therefore, Blockchain will be more and more attractive tool to perform the logistic sector, as a way of get a competitive advantage. Moreover, there is a lot of opportunities to provide valor to the customer with this technology.

However, there are certain challenges associated to the implementation of Blockchain as it is a emergent technology which no many business have already instaled. In addition, it is not a easy task to insert and implement this technology and get profit in a short period of time. Blockchain will have to become not only more scalable but also durable as well.

Moreover, the SWOT analysis provided us the main weakness and threats presented in this technology. This information can be verified by the interview participants as they think that the main weakness and threats are the same as the SWOT analysis. In this case, it can be concluded that it is crucial to continue with the investigation of this lack of information related to these topics as vulnerability or automation.

Finally, another important closure is the importance of cost reduction. Many papers agree that Blokchain would reduce the cost but companies consider this property as a opportunity which means that they don't belive that current blockchain systems can produce additional expenditure savings.

These conclusions have been determined taking into account the previous studies, the SWOT analysis and the final interview

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